COMMERCE, JUSTICE, SCIENCE, AND RELATED AGENCIES APPROPRIATIONS FOR FISCAL YEAR 2012

MONDAY, APRIL 11, 2011

U.S. SENATE,
SUBCOMMITTEE OF THE COMMITTEE ON APPROPRIATIONS,
Washington, DC.

The subcommittee met at 4:05 p.m., in room SD–192, Dirksen Senate Office Building, Hon. Barbara A. Mikulski (chairman) presiding.

Present: Senators Mikulski, Brown, Hutchison, and Cochran.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

STATEMENT OF HON. CHARLES F. BOLDEN, JR., ADMINISTRATOR

OPENING STATEMENT OF SENATOR BARBARA A. MIKULSKI

Senator MIKULSKI. The Subcommittee on Commerce, Justice, Science, and Related Agencies will come to order today.

We take the testimony of the current Administrator and former astronaut, the Honorable Major General Charles F. Bolden, Jr., to review the National Aeronautics and Space Administration (NASA) fiscal year 2012 budget request and to also talk about how this might be also in light of what we just have gone through.

Administrator Bolden, we're glad to see you. We want to thank you for coming on a Monday at 4 o'clock. Our hearing normally occurs on Thursday mornings. We couldn't do this when we thought we could. But, Senator Kay Bailey Hutchison and I did not want to delay the hearing, because it would have taken us after the Easter/Passover recess, and we wanted to be able to really get cracking on our fiscal year 2012 appropriations. So, we thank you for doing this. And we look forward to your testimony.

Well, I'm glad to see you and we're glad to be here. And so, both of us—all of us—were declared essential.

I know that what we just lived through last week was a cliffhanger. It rattled many people. It certainly rattled us. We felt that it would have been a disaster, had we had a shutdown, to, really, the economy and the reputation of the United States of America. We have now been called upon to accept $78 billion worth of cuts from the President's 2011 request, $39 billion below the 2010 level. That was the mark that was given us.

Now, all of our staffs have worked through the night. And I'd like to thank Senator Hutchison's staff for really hanging in there and working with us.

And I might add, Administrator Bolden, that Congressman Wolf and Congressman Fattah, we all worked pretty tirelessly to meet our obligation to be able to report out a bill—not only in this subcommittee—tonight at midnight. So, you'll hear about a lot of things. And we want to hear from you about where we think you are.

We're very proud of NASA. This is the 50th anniversary of President Kennedy's call to send a person to the Moon and return them safely. From our human spaceflight and our visit to the Moon, our ambitions to even go further, we're so proud of what we've done in human spaceflight, and we look forward to supporting human spaceflight initiatives.

When we look ahead, when we look at space science, the wonders of the Hubble Space Telescope, to others in the area of Earth science, planetary science, Helio science, protecting our power grid are all important.

We know that what NASA does is part of really creating the new ideas for the innovation economy. Today, at a speech to the Maryland Space Roundtable, I said every time NASA lifts off, it takes the American economy with us, because it is about innovation and it is about jobs.

Last year, the Congress gave NASA a new path forward. Ranking Member Hutchison and I worked with Senator Bill Nelson on a new authorization bill. And I'd like to compliment the gentlelady from Texas in what she and Chairman Nelson were able to achieve. We believe that is the framework that we could achieve. It meets the President's priorities, but understands the priorities of the space coalition here in the Senate for a very balanced space program.

We need investments in science and aeronautics, but we also must remember, we want human spaceflight, we want human spaceflight to be sustainable, being able to go to the International Space Station (ISS) until 2020 and also broadening our human reach beyond low-Earth orbit (LEO) with the Orion capsule and a heavy-lift rocket. We have lots of ambitions, and now we're trying to see if we have the wallet to match it. I will work tirelessly to implement a balanced space program.

Last year, we agreed to $19 billion. Well, it's not going to come out quite that way. And so, for this year, we're anticipating, in appropriations, if we stick to the President's request, $18.7 million. We know that the science request is at $5 billion. And we also need to make sure important projects like that don't get out from under us, like the James Webb Space Telescope (JWST). And I'll focus more on that in the questions.

I'm also concerned about aeronautics research. I'm afraid we're falling away and falling behind in that area. Our European counterparts are making very heavy investments in aeronautics research, and I hope—they would like to dominate civilian aeronautics. Well, I just don't think it is fun to go to the Paris Air Show to hear about what Paris is doing. I want to go to the—when America goes, it's because we're really doing the best of the best.

We know that the budget requests $2.8 billion for a new rocket in the Orion capsule for the human spaceflight program. And we have to take a good look at that.

We're also very impressed at what is going on, however, in Commercial Orbital Transportation Services (COTS), particularly as it relates to cargo. We think that's going to be a very big success story, that we'll be able to take cargo, through unmanned spacecraft, to the space station while we observe, watch, and see where we go in human spaceflight. We will also maintain our accountability and our oversight.

But, we want to get to you, rather than my opening statement.

I'm going to turn to the ranking member, someone who we've really—we've worked on space now three terms, haven't we?

Senator HUTCHISON. Yes.

Senator MIKULSKI. And I am so glad that we're colleagues here on this matter.

I'm going to turn to Senator Hutchison.

OPENING STATEMENT OF SENATOR KAY BAILEY HUTCHISON

Senator HUTCHISON. Well, I want to thank you, Madam Chairman, because you have indeed been a partner in trying to make the very best efforts for NASA in all of its missions.

And I particularly want to thank the chairman's staff director, Gabrielle Batkin, for working with my staff so closely to assure that NASA does have a balanced plan, going forward, that will achieve the results that we all want.

I thank you for coming. And, as the chairman mentioned, we are at some very major anniversaries and some very major crossroads.

We're about to see the end of our Nation's ability to launch our own astronauts into space. The space shuttles have served our country well for 30 years and have made it possible to construct an amazing science platform in space, the ISS. While NASA should be making plans to fully utilize the station using our own launch capabilities, I don't think that is happening. We could be working with our international partners, with our universities, and with companies that could capitalize on our unique national lab in space. In fact, it was the Commerce Committee, in our authorization, that created our part of the space station as a national lab in order to be able to attract private and university/academic funding for research. And that is just beginning to bear fruit.

But, now I see the administration placing our investment in the space station and its capabilities at risk, as well as our future exploration capabilities. Once the shuttles are retired, we will be reduced to buying seats on Russian vehicles for the foreseeable future. The Russians have been our long-time partners with the space station, but we should not expect them to shoulder their space program and ours, when we should be able to do it ourselves.

NASA has the Orion capsule, which it has invested significant time and resources in, to carry our astronauts. And yet, to this day, NASA is refusing to allow it to move forward. The President personally revived Orion last year, and the Congress followed, reinstating it as a vehicle that will take us to an asteroid or even back to the Moon.

I heard from your associate administrators, last month in the Commerce Committee, that they understand that the authorization law directs the building of a capsule and a heavy-lift vehicle. They know that Orion fits the bill as the multipurpose crew vehicle

(MPCV) and that it will take very little to modify the contracts, as allowed for in the authorization law. In fact, even the scope of the contract would need little alteration.

Like the President, I have no problem continuing to call the capsule we are developing Orion, yet we see no movement from NASA to continue the program at all. This budget proposes only $1 billion for Orion in fiscal year 2012, while the authorized level for the same year calls for $1.4 billion; and the plan for ongoing work, prior to NASA's cancellation attempts, would have had it at $2 billion. This budget deliberately hamstrings the ability for Orion to reach an operability date in 2016.

The fiscal year 2012 vision for human spaceflight offered as a variant of the authorization is the creation of new prime contractors and providing them with development funds. It is NASA's hope that providing venture capital will—that they then will be able to usher in a new era in space exploration. But, there is little proof that what is being promised can be reality.

The COTS program is finally beginning to show promise, but it is significantly behind schedule. Last year, NASA proposed a 60 percent increase in funds to assure that the program would be successful. But, because it has been slower to produce results, the STS–135 flight has now become critical for the near-term viability of the space station. The NASA authorization bill leaves primary crew vehicle delivery to the space station open to commercial entities, with Orion as a backup. However, given the track record so far for cargo and NASA's underfunded budget proposal for existing programs, the Nation could find itself with neither crew option available when our latest renegotiated contract with the Russians ends.

PREPARED STATEMENT

What we have done is allowed for a mix of Government and commercial to cover all of our country's needs. NASA needs to find a proper and justified balance without placing our human space program at risk. While I know that commercial companies could eventually become successful, I do not feel that the information available justifies such a large investment of Federal dollars this year for commercial vehicles. I also believe that the same scrutiny that has been placed upon our other manned vehicle should be applied to commercial crew to ensure that viability and safety of our astronauts are ensured.

So, Mr. Administrator, I will put the rest of my statement in the record. But, I am hoping that we can establish a partnership, going forward, that adheres to the authorization law, that is a balance, that does provide the funds for the commercial vehicle, but not at the expense of Orion and all of the capabilities to use what we've already spent billions to do productively, going forward.

[The statement follows:]

PREPARED STATEMENT OF SENATOR KAY BAILEY HUTCHISON

Mr. Administrator, thank you for coming to discuss National Aeronautics Administration (NASA) fiscal year 2012 budget. We are meeting on the eve of the 50th anniversary of the first human launched into space and the 30th anniversary of the very first shuttle launch. Space faring countries have accomplished many amazing things, and I hope that we can work together to help accomplish many more.

These are unusual times to be discussing the future of NASA when the budget for the current year is only just now being settled.

HUMAN SPACE FLIGHT

We are about to see the end of our Nation's ability to launch our own astronauts into space. The space shuttles have served our country well for the past 30 years and have made it possible to construct an amazing science platform in space, the international space station.

While NASA should be making plans to be fully utilizing the station using our own launch capabilities, that is not happening. We could be working with our international partners, with our universities, and with companies that could capitalize on our unique national lab in space.

Instead, this administration places our investment in the space station and its capabilities, as well as our future exploration capabilities at serious risk.

Once the shuttles are retired, we will be reduced to buying seats on Russian vehicles for the foreseeable future. The Russians have been our long time partners with the space station, but we should not expect them to shoulder their space program and ours when we should be able to do it ourselves.

NASA has the Orion capsule, in which it has invested significant time and resources to carry our astronauts, yet to this day, NASA refuses to allow it to move forward. The President personally revived Orion last year, and the Congress followed, reinstating it as the vehicle that will take us to an asteroid, or even back to the Moon.

I heard from your associate administrators last month that they understand the authorization law directs the building of a capsule and a heavy lift vehicle. They know that Orion fits the bill as the MPCV, and that it will take very little to modify the contracts, as allowed for in the authorization law. In fact, even the scope of the contract would need little alteration. Like the President, I have no problem continuing to call the capsule we are developing Orion, yet we see no movement from NASA to continue this program at all.

This budget proposes only $1 billion for Orion in fiscal year 2012, while the authorized level for the same year calls for $1.4 billion and the plan for ongoing work prior to NASA's misguided cancellation attempt, would have had it at $2 billion. This budget deliberately hamstrings the ability for Orion to reach an operability date in 2016.

COMMERCIAL

The fiscal year 2012 vision for human space flight, offered as a variant of the authorization, is the creation of new prime contractors and providing them with development funds. It is NASA's hope that by providing venture capital, they will usher in a new era in space exploration with little proof that what is being promised can be reality.

The Commercial Orbital Transportation Services program is finally beginning to show promise, but it is significantly behind schedule. Last year NASA proposed a 60 percent increase in funds to assure that the program would be successful. Because this program has been slower to produce results than expected, the STS–135 flight has now become absolutely critical for the near-term viability of the space station.

The NASA authorization leaves primary crew delivery to the space station open to commercial entities with Orion as a backup. However, given the track record so far for cargo and NASA's underfunded budget proposal existing programs, the Nation could find itself with neither crewed option available when our latest renegotiated contract with the Russians ends.

What we have done is allowed for a mix of government and commercial to cover all of our county's needs. NASA needs to find a proper, and justified, balance without placing our human space program at risk.

While I know the commercial companies could eventually become successful, I do not feel that the information available justifies such a large investment of Federal dollars this year for commercial crew vehicles. I also believe that the same scrutiny that has been placed upon our other manned vehicles should be applied to commercial crew to ensure that viability and safety of our astronauts are ensured.

CLOSE

Instead of embracing the hard fought compromises that would lead to a robust and balanced space agency, we see a reliance on a new and novel way of doing space flight, and hoping it may work out in the end.

That is not responsible, nor is there any proof that it will ultimately be successful without substantial funding for development and guaranteed business from NASA.

We have just come from a year where battle lines were drawn because of a flawed budget proposal. I do not want to return to the issues of the past, but the proposal before us today continues to perpetuate a false hope. This hope places our entire human space flight program at risk while a talented workforce is being let go as NASA further delays what it can, and should be doing.

Mr. Administrator, you have a voice in shaping NASA, and it will set the tone for shaping the future for generations. I can only hope that you will use that voice to rise to the occasion.

You have great supporters of NASA on this subcommittee. Do not allow agendas that are counter to what is the law squander your opportunity to keep NASA at the forefront of exploration.

You have been given the tools to move forward expeditiously. All that needs to be done now is to move forward.

Thank you.

Senator HUTCHISON. Thank you, Madam Chairman. And I yield back to you.

Senator MIKULSKI. Yes.

I'd like to acknowledge the presence of Senator Sherrod Brown, from Ohio, a new but very active member of the subcommittee.

Senator, do you want to say something, or you want to wait for your——

Senator BROWN. I'll say only 30 seconds' worth.

STATEMENT OF SENATOR SHERROD BROWN

First of all, thank you for welcoming me to this subcommittee on—in all of the jurisdictions, including the NASA jurisdiction that's particularly important to me.

I appreciate General Bolden's coming to Cleveland, to Glenn Space Center a number of times, and speaking at the City Club and laying out a NASA vision.

I also am concerned, as I know we all are, at what the NASA budget may look like in the months ahead with H.R. 1, with the new Orion budget, introduced in the House last week, and with the tax-cut fervor that seems to be sweeping some parts of the House and Senate—what that's going to mean on funding one of the most important parts of the Federal Government; that is, the innovation, the research, the missions, the advantage in aeronautics that we have had as a country for decades in making sure that we can continue to be the leading edge there. But, if we're going to cut taxes and continue to cut taxes on the wealthiest people in this country, and continue to underfund the important parts of Government, we're going to lose that scientific edge. And I know General Bolden is helping to lead the charge on making sure that we don't lose it. And I appreciate his work on that.

Thank you, Madam Chair.

Senator MIKULSKI. Administrator Bolden.

SUMMARY STATEMENT OF CHARLES F. BOLDEN, JR.

General BOLDEN. Chairman Mikulski and Ranking Member Hutchison, good afternoon and thank you for the opportunity to discuss with you NASA's fiscal year 2012 budget request. I thank you very much for being here, Senator Brown, always good to see you.

Senator BROWN. You, too.

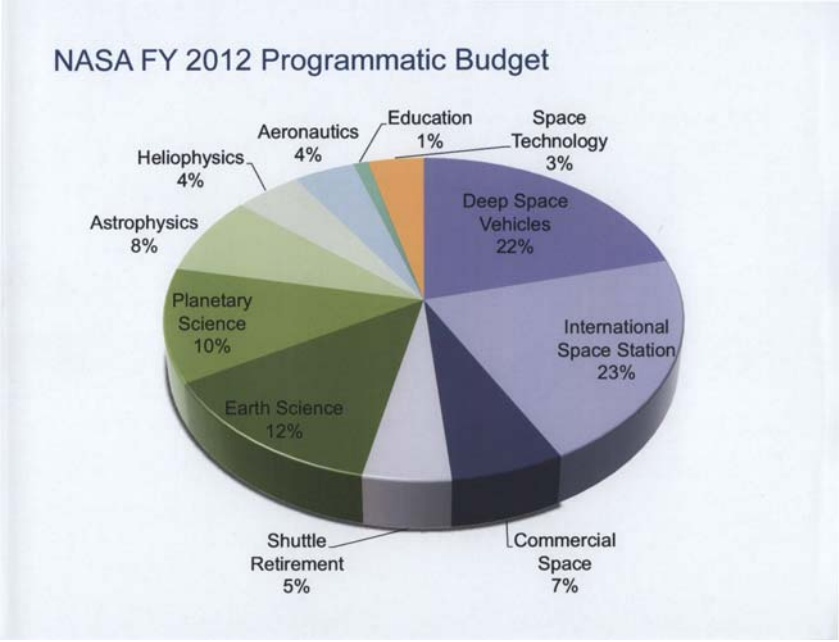
General BOLDEN. Senator Mikulski, as chair of this subcommittee, you've continued to provide critical leadership and oversight of our Nation's space program. And I would like to recognize Senator Hutchison, a longtime member of the subcommittee, in her new leadership role as ranking member of this subcommittee. I want to thank both of you and the members of this subcommittee for the long-standing support that you have given to NASA. We have a common passion for science, aeronautics, and space exploration and the benefits they bring our Nation. I look forward to our continuing to work together in the same collegial fashion as we have in the past.

It's my privilege today to discuss the President's fiscal year 2012 budget request of $18.7 billion for NASA. Recognizing the President's commitment to fiscal restraint, I am pleased that we are proposing to hold funding at the level appropriated for fiscal year 2010.

This fiscal year 2012 budget request continues the agency's focus on a reinvigorated path of innovation and technological discovery leading to an array of challenging destinations and missions that engage the public.

Madam Chair, you and each member of the subcommittee should have two charts before you, to which I call your attention.

Chart 1, the pie chart, shows at very high level the scope of NASA's proposed fiscal year 2012 budget, which represents a balanced and integrated program. The NASA Authorization Act of 2010 has given the agency a clear direction. NASA is moving forward to implement the details of that act with this fiscal year 2012 budget.



As you can see in chart 2, the President's fiscal year 2012 budget request for NASA funds all major elements of the NASA Authorization Act while supporting a diverse portfolio of key programs.

[The information follows:]

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION—PRESIDENT'S FISCAL YEAR 2012 BUDGET REQUEST DETAIL—FULL COST VIEW

[Budget authority, in million of dollars]

	Actual fiscal year 2010	Continuing resolution fiscal year 2011	Authorization act fiscal year 2011	Fiscal year 2012	Fiscal year 2013	Fiscal year 2014	Fiscal year 2015	Fiscal year 2016
Science:								
Earth Science	1,439.3	.....	1,801.8	1,797.4	1,821.7	1,818.5	1,858.2	1,915.4
Planetary Science	1,364.4	.....	1,485.7	1,540.7	1,429.3	1,394.7	1,344.2	1,256.8
Astrophysics	647.3	.....	1,076.3	682.7	758.1	775.5	779.8	810.9
James Webb Space Telescope	438.7	.....	.....	373.7	375.0	375.0	375.0	375.0
Heliophysics	608.0	.....	641.9	622.3	632.7	653.0	659.7	658.7
Total, Science	4,497.6	4,469.0	5,005.6	5,016.8	5,016.8	5,016.8	5,016.8	5,016.8
Aeronautics	497.0	501.0	579.6	569.4	569.4	569.4	569.4	569.4
Space technology	275.2	327.2	512.0	1,024.2	1,024.2	1,024.2	1,024.2	1,024.2
Exploration:								
Human Exploration Capabilities	3,287.5	.....	2,751.0	2,810.2	2,810.2	2,810.2	2,810.2	2,810.2
Commercial Spaceflight	39.1	.....	612.0	850.0	850.0	850.0	850.0	850.0
Exploration Research and Development	299.2	.....	343.0	288.5	288.5	288.5	288.5	288.5
Total, Exploration	3,625.8	3,594.3	3,706.0	3,948.7	3,948.7	3,948.7	3,948.7	3,948.7
Space Operations:								
Space Shuttle	3,101.4	.....	1,609.7	664.9	79.7	0.8	0.8	0.9
International Space Station	2,312.7	.....	2,779.8	2,841.5	2,960.4	3,005.4	3,098.0	3,174.8
Space and Flight Support	727.7	.....	1,119.0	840.6	1,306.8	1,340.7	1,248.1	1,171.2
Total, Space Operations	6,141.8	6,146.8	5,508.5	4,346.9	4,346.9	4,346.9	4,346.9	4,346.9
Education	180.1	182.5	145.8	138.4	138.4	138.4	138.4	138.4
Cross-Agency Support:								
Center Management and Operations	2,161.2	.....	.....	2,402.9	2,402.9	2,402.9	2,402.9	2,402.9
Agency Management and Operations	766.2	.....	.....	789.1	789.1	789.1	789.1	789.1
Institutional Investments	27.2	.....	.....	.....	.....	.....	.....	.....
Congressionally Directed Items	63.0	.....	.....	.....	.....	.....	.....	.....

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION—PRESIDENT'S FISCAL YEAR 2012 BUDGET REQUEST DETAIL—FULL COST VIEW—Continued

[Budget authority, in million of dollars]

	Actual fiscal year 2010	Continuing resolution fiscal year 2011	Authorization act fiscal year 2011	Fiscal year 2012	Fiscal year 2013	Fiscal year 2014	Fiscal year 2015	Fiscal year 2016
Total, Cross-Agency Support	3,017.6	3,018.8	3,111.4	3,192.0	3,192.0	3,192.0	3,192.0	3,192.0
Construction and Environmental Compliance and Restoration:								
Construction of Facilities	389.4	.....	.....	397.9	384.0	359.5	362.9	360.0
Environmental Compliance and Restoration	63.4	.....	.....	52.5	66.4	90.9	87.5	90.4
Total, Construction and Environmental Compliance and Restoration	452.8	448.3	394.3	450.4	450.4	450.4	450.4	450.4
Inspector General	36.4	36.4	37.0	37.5	37.5	37.5	37.5	37.5
Total, NASA fiscal year 2011	18,724.3	18,724.3	19,000.0	18,724.3	18,724.3	18,724.3	18,724.3	18,724.3

General BOLDEN. Because these are tough fiscal times, we have had to make some tough and some difficult choices. Reductions have been necessary in some areas so that we can invest in the future while living within our means. This budget request maintains a strong commitment to human spaceflight, science, aeronautics, and the development of new technologies, and education programs that will help us win the future. It carries out programs of innovation to support long-term job growth in a dynamic economy that will help us out-innovate, out-educate, and out-build all others in the world.

Along with our fiscal year 2012 budget request, we published our 2011 Strategic Plan. If you don't have it or the staffs don't have it, if you'll let us know, we'll make certain that we get a copy to everybody.

NASA's core mission remains fundamentally the same as it has been since our inception in 1958. It supports our vision, as shown in the strategic plan, "To reach new heights and reveal the unknown, so that what we do and learn will benefit all humankind."

On March 9, we completed the STS–133 mission, one of the final three shuttle flights to the ISS. *Discovery* delivered a robotic crewmember, Robonaut 2, or R2 as we like to call him—it—and supplies that will support the station's scientific research and technology demonstrations. That was a joke, by the way. I didn't—okay.

We are currently preparing the Space Shuttle *Endeavor* for the STS–134 mission, to be launched on April 29, which will deliver the alphamagnetic spectrometer, or AMS. The AMS experiment will use the unique environment of space to advance knowledge of the universe and lead to the understanding of the universe's origin. This will be the 36th shuttle mission to the station, and the final flight for *Endeavor*.

With the impending completion of the shuttle manifest with STS–135, it's my plan to announce my decisions regarding the recipients of shuttle orbiters tomorrow, April 12, 2011, the 30th anniversary of the first space shuttle flight.

Our space program continues to venture in ways that will have long-term benefits. There are many more milestones in the near term. Our priorities in human spaceflight in the fiscal year 2012 budget request are to maintain safe access for American astronauts to LEO as we fully utilize the ISS; to facilitate safe, reliable, and cost-effective U.S.-provided commercial access to LEO for American astronauts and their supplies as soon as possible; to begin to lay the groundwork for expanding human presence into deep space, the Moon, asteroids, and eventually Mars, through development of a powerful, evolvable heavy lift rocket and MPCV; and to pursue technology development to carry humans farther into the solar system.

These initiatives will enable America to retain its position as a leader in space exploration for generations to come. At the same time, in our other endeavors, our priorities are to extend our reach with scientific observatories, to learn more about our home planet and the solar system, and peer beyond it to the origins of the universe.

This budget request funds 56 NASA science missions currently in operation, and 28 more in various stages of development. Just

as one example, on March 17 of this year, after traveling more than 6 years and 4.9 billion miles, NASA's MESSENGER (MEcury Surface, Space, ENvironment, GEochemistry and Ranging) spacecraft successfully entered orbit around Mercury. The MESSENGER spacecraft will give us our first look at the planet from orbit, help us understand the forces that shaped it, and provide a fundamental understanding of the terrestrial planets and their evolution. In addition, we will pursue groundbreaking research into the next generation of aviation technologies and carry out dynamic education programs that help develop the next generation of science, technology, engineering, and mathematics professionals.

That's a lot, but NASA thrives on doing big things. We have vastly increased human knowledge, and our discoveries and technologies have improved life here on Earth. In spite of the difficulties that we've encountered with the very critical JWST, we've made changes in our management, increased our oversight from my office, and continued to work with the program to develop a revised baseline by the end of April that will include options addressing light funding scenarios. The official plan will be submitted as part of our fiscal year 2013 budget.

I want to commend the NASA workforce, both civil service and contractors across the Nation, for their dedication to our missions during this time of transition and change. These workers are our greatest asset and they make us all proud. They fully understand the risk of our exploration and welcome the challenge. They will be the ones making tomorrow happen.

These are exciting and dynamic times for us at NASA. The challenges ahead are significant, but so are the opportunities. We have to achieve big things that will create a measurable impact on our economy, our world, and our way of life.

PREPARED STATEMENT

I thank you again for the opportunity to appear before this subcommittee, and I look forward to taking your questions.

Senator MIKULSKI. Thank you, Administrator Bolden. And I know you have given us a far more ample and detailed statement.

General BOLDEN. Yes, ma'am.

Senator MIKULSKI. I'm going to ask unanimous consent that, along with your oral testimony, that this detailed statement be included in the record.

[The statement follows:]

PREPARED STATEMENT OF CHARLES F. BOLDEN, JR.

Madam Chair and members of the subcommittee, today it is my privilege to discuss the President's fiscal year 2012 budget request of $18.7 billion for the National Aeronautics and Space Administration (NASA). This request continues NASA's focus on a reinvigorated path of innovation and technological discovery leading to an array of challenging destinations and missions that increases our knowledge, develops technologies to improve life and expand our presence in space for knowledge and commerce, and engages the public. With the President's signing of the NASA Authorization Act of 2010 (Public Law 111–267) on October 11, 2010, NASA has a clear direction and is moving forward. NASA appreciates the significant efforts that advanced this important bipartisan legislation, particularly efforts by the leadership and members of this subcommittee. This is a time of opportunity for NASA to shape a promising future for the Nation's space program.

Because these are tough fiscal times, tough choices had to be made. But the proposed fiscal year 2012 budget funds all major elements of the authorization act, sup-

porting a diverse portfolio of programs, while making difficult choices to fund key priorities and reduce other areas in order to invest in the future. A chart summarizing the President's fiscal year 2012 budget request for NASA is enclosed as Enclosure 1.

We have an incredible portfolio of human space flight, science, aeronautics, and technology development. Within the human space flight arena, our foremost priority is our current human spaceflight endeavor—the International Space Station (ISS)—and the safety and viability of the astronauts aboard it. The request also maintains a strong commitment to human spaceflight beyond low-Earth orbit (LEO). It establishes critical priorities and invests in the technologies and excellent science, aeronautics research, and education programs that will help us win the future. The request supports an aggressive launch rate over the next 2 years with about 40 U.S. and international missions to the ISS, for science, and to support other agencies.

At its core, NASA's mission remains fundamentally the same as it always has been and supports our new vision: "To reach for new heights and reveal the unknown so that what we do and learn will benefit all humankind." This statement is from the new multi-year 2011 NASA Strategic Plan accompanying the fiscal year 2012 budget request, which all of NASA's Mission Directorates, Mission Support Offices and Centers helped to develop, and encapsulates in broad terms the very reason for NASA's existence and everything that the American public expects from its space program.

On March 1, we outlined for the subcommittee our plan to establish new Exploration program offices to carry out our future work on the Multi-Purpose Crew Vehicle, Space Launch System, and Commercial Crew.

On March 9, we completed the Space Shuttle *Discovery*'s STS–133 mission, 1 of the final 3 shuttle flights to the ISS. Discovery delivered a robotic crewmember, Robonaut-2 (R2), and supplies that will support the station's scientific research and technology demonstrations. And we are currently preparing the Space Shuttle *Endeavour* for the STS–134 mission to be launched on April 29, which will deliver the Alpha Magnetic Spectrometer, or AMS, and space parts including two S-band communications antennas, a high-pressure gas tank, additional spare parts for Dextre, and micrometeroid debris shield to the station.

Our human spaceflight priorities in the fiscal year 2012 budget request are to:

—Safely fly the last space shuttle flights this year and maintain safe access for humans to LEO orbit as we fully utilize the ISS;

—Facilitate safe, reliable, and cost-effective U.S.-provided commercial access to LEO first for cargo and then for crew as quickly as possible;

—Begin to lay the groundwork for expanding human presence into deep space—the Moon, asteroids, eventually Mars—through development of a powerful heavy-lift rocket and multipurpose crew capsule; and

—Pursue technology development that is needed to carry humans farther into the solar system. Taken together, these human spaceflight initiatives will enable America to retain its position as a leader in space exploration for generations to come.

At the same time, we will extend our reach with robotic spacecraft and scientific observatories to expand our knowledge of the universe beyond our own planet. We will continue the vital work to expand our abilities to observe our planet Earth and make that data available for decisionmakers. We will also continue our groundbreaking research into the next generation of aviation technologies. Finally, we will make the most of all of NASA's technological breakthroughs to improve life here at home.

With the fiscal year 2012 budget, NASA will carry out research, technology, and innovation programs that support long-term job growth and economic competitiveness and build upon our Nation's position as a technology leader. We will educate the next generation of technology leaders through vital programs in science, technology, engineering, and mathematics education. And we will build the future through investments in American industry, creating high-tech jobs across the country and an innovation engine for the U.S. economy.

This year we honor the legacy of President John F. Kennedy, who, 50 years ago, set the United States on a path that resulted in a national effort to produce an unprecedented achievement. Now, we step forward along a similar path, engaged in a wide range of activities in human spaceflight, science, and aeronautics—a path characterized by engagement of an expanded commercial space sector and technology development to mature the capabilities required by increasingly challenging missions designed to make discoveries and reach new destinations.

NASA's Science Mission Directorate (SMD) continues to rewrite textbooks and make headlines around the world. Across disciplines and geographic regions worldwide, NASA aims to achieve a deep scientific understanding of Earth, other planets

and solar system bodies, our star system in its entirety, and the universe beyond. The agency is laying the foundation for the robotic and human expeditions of the future while meeting today's needs for scientific information to address national concerns about global change, space weather, and education.

—The Mars Science Laboratory will launch later this year and arrive at Mars in August 2012. It will be the largest rover ever to reach the Red Planet and will search for evidence of both past and present life.

—The Nuclear Spectroscopic Telescope Array (NuSTAR) mission will launch in early 2012 and become the first focusing hard xray telescope to orbit Earth.

—Research and analysis programs will use data from an array of sources, including spacecraft, sounding rockets, balloons, and payloads on the ISS. We will continue to evaluate the vast amounts of data we receive from dozens of ongoing missions supported by this budget.

—A continued focus on Earth science sees us continuing development of the Orbiting Carbon Observatory-2 (OCO–2) for launch in 2013 and other initiatives to collect data and conduct research on a broad spectrum of changes in the Earth system including climate, weather, and natural hazards.

—The budget reflects the scientific priorities for astrophysics as expressed in the recent Decadal Survey of the National Academy of Sciences. The budget supports small-, medium-, and large-scale activities recommended by the Decadal Survey.

—The Radiation Belt Storm Probe mission will launch next year, and development of other smaller missions and instruments to study the Sun will get underway here on the ground.

With the appointment of a new Chief Scientist, NASA will pursue an integrated, strategic approach to its scientific work across Mission Directorates and programs.

As we continue our work to consolidate the Exploration Systems Mission Directorates (ESMD) and Space Operations Mission Directorates, both groups will support our current human spaceflight programs and continue work on technologies to expand our future capabilities.

—We will fly out the space shuttle in 2011, including STS–135 if funds are available, and then proceed with the disposition of most space shuttle assets after the retirement of the fleet. The shuttle program accomplished many outstanding things for this Nation, and in 2012 we look forward to moving our retired Orbiters to new homes across the country to inspire the next generation of explorers.

—Completing assembly of the U.S. segment of the ISS will be the crowning achievement of the space shuttle's nearly 30-year history. The ISS will serve as a fully functional and permanently crewed research laboratory and technology testbed, providing a critical stepping stone for exploration and future international cooperation, as well as an invaluable National Laboratory for non-NASA and nongovernmental users. During fiscal year 2011, NASA will award a cooperative agreement to an independent nonprofit organization (NPO) with responsibility to further develop this effort. The NPO will oversee all ISS research involving organizations other than NASA, and transfer current NASA biological and physical research to the NPO in future years.

—In 2012, we will make progress in developing a new Space Launch System (SLS), a heavy-lift rocket that will be the first step on our eventual journeys to destinations beyond LEO.

—We will continue work on a MPCV that will build on the human safety features, designs, and systems of the Orion Crew Exploration Vehicle. As with the SLS, acquisition strategy decisions will be finalized by this summer.

—NASA will continue to expand commercial access to space and work with our partners to achieve milestones in the Commercial Orbital Transportation Services (COTS) program, the Commercial Resupply Services (CRS) effort, and an expanded Commercial Crew Development (CCDev) program. As we direct resources toward developing these capabilities, we not only create multiple means for accessing LEO, but we also facilitate commercial uses of space, help lower costs, and spark an engine for long-term job growth. While the request is above the authorized level for 2012, NASA believes the amount is critical, combined with significant corporate investments, to ensure that we will have one or more companies that can transport American astronauts to the ISS. With retirement of the space shuttle in 2011, this is a top agency priority.

—Most importantly, NASA recognizes that these programmatic changes will continue to personally affect thousands of NASA civil servants and contractors who have worked countless hours, often under difficult circumstances, to make our human spaceflight, science, and aeronautics programs and projects successful. I commend the investment that these dedicated Americans have made and will

continue to make in our Nation's space and aeronautics programs. These are tremendously exciting and dynamic times for the U.S. space program. NASA will strive to utilize our workforce in a manner that will ensure that the Nation maintains NASA's greatest asset—the skilled civil servants and contractors—while working to increase the efficiency and cost-effectiveness in all of its operations.

—The 21st Century Space Launch Complex program will focus on upgrades to the Florida launch range, expanding capabilities to support SLS, MPCV, commercial cargo/launch services providers, and transforming KSC into a modern facility that benefits all range users. The program will replan its activities based on available fiscal year 2011 funding to align with 2010 NASA Authorization's focus areas, including cross organizational coordination between 21st CSLC, Launch Services, and Commercial Crew activities.

NASA's Aeronautics Research Mission Directorate (ARMD) continues to improve the safety, efficiency, and environmental friendliness of air travel.

—Our work continues to address the challenge of meeting the growing technology and capacity needs of the Next Generation air travel system, or "NextGen", in coordination with the FAA and other stakeholders in airspace efficiency.

—NASA's work on green aviation technologies that improve fuel efficiency and reduce noise continues apace.

—We also continue to work with industry to develop the concepts and technologies for the aircraft of tomorrow. The agency's fundamental and integrated systems research and testing will continue to generate improvements and economic impacts felt by the general flying public as well as the aeronautics community.

The establishment last year of the Office of the Chief Technologist (OCT) enabled NASA to begin moving toward the technological breakthroughs needed to meet our Nation's space exploration goals, while building our Nation's global economic competitiveness through the creation of new products and services, new business and industries, and high-quality, sustainable jobs. By investing in high-payoff, transformative technology that industry cannot tackle today, NASA matures the technology required for our future missions in science and exploration while improving the capabilities and lowering the cost of other Government agencies and commercial activities.

—NASA recently developed draft space technology roadmaps, which define pathways to advance the Nation's capabilities in space and establish a foundation for the agency's future investments in technology and innovation. NASA is working collaboratively with the National Research Council (NRC) to refine these roadmaps. The final product, expected in the first quarter of fiscal year 2012, will establish a mechanism for prioritizing NASA's technology investments, and will support the initial Space Technology Policy Congress requested in the NASA Authorization Act of 2010.

—Through the Space Technology program, OCT will sponsor a portfolio of both competitive and strategically guided technology investments, bringing the agency a wide range of mission-focused and transformative technologies that will enable revolutionary approaches to achieving NASA's current and future missions.

—In fiscal year 2012, a significant portion of the Exploration Technology Development Program is moved from ESMD to space technology. These efforts focus on developing the long-range, exploration-specific technologies to enable NASA's deep space human exploration future. The integration of exploration technology activities with space technology eliminates the potential for overlap had NASA's space technology investments been split among two accounts. ESMD will continue to set the prioritized requirements for all exploration technology development efforts and will serve as the primary customer of these mission-specific technology development activities.

—OCT continues to manage SBIR and STTR, and integrates technology transfer efforts to ensure that NASA technologies are infused into commercial applications, develops technology partnerships, and facilitates emerging commercial space activities

Recognizing that our work must continuously inspire not only the public at large but also students at all levels, NASA's Education programs this year focus on widening the pipeline of students pursuing coursework in STEM. As President Obama has said, "Our future depends on reaffirming America's role as the world's engine of scientific discovery and technological innovation. And that leadership tomorrow depends on how we educate our students today, especially in math, science, technology, and engineering."

—The fiscal year 2012 request for NASA's Office of Education capitalizes on the excitement of NASA's mission through innovative approaches that inspire educator and student interest and proficiency in STEM disciplines. NASA's edu-

cation program in fiscal year 2012 and beyond will focus and strengthen the agency's tradition of investing in the Nation's education programs and supporting the country's educators who play a key role in inspiring, encouraging, and nurturing the young minds of today, who will manage and lead the Nation's laboratories and research centers of tomorrow.

—Among NASA's Education activities will be a continued Summer of Innovation, building on the successful model piloted with four States this past year.

All of these activities place NASA in the forefront of a bright future for America, where we challenge ourselves and create a global space enterprise with positive ramifications across the world. The fiscal year 2012 budget request provides the resources for NASA to innovate and make discoveries on many fronts, and we look forward to implementing it. See Enclosure 2 for a more detail summary of each activity.

CONCLUSION

As we enter the second half-century of human spaceflight, the Nation can look back upon NASA's accomplishments with pride, but we can also look forward with anticipation to many more achievements to come. The NASA Authorization Act of 2010 (Public Law 111–267) has provided us with clear direction that enables the agency to conduct important research on the ISS, develop new launch vehicles and crew transportation capabilities to go beyond the bounds of LEO, utilize a dazzling array of spacecraft to study the depths of the cosmos while taking the measure of our home planet, improve aviation systems and safety, develop new technologies that will have applications to both space exploration and life on Earth, and inspire the teachers and students of our country. In developing and executing the challenging missions that only NASA can do, we contribute new knowledge and technologies that enhance the Nation's ability to compete on the global stage and help to secure a more prosperous future.

These are tough fiscal times, calling for tough choices. The President's fiscal year 2012 budget request makes those choices and helps advance all of these bold aims, and we look forward to working with the subcommittee on its implementation.

Madam Chair, thank you for your support and that of this subcommittee. I would be pleased to respond to any questions you or the other members of the subcommittee may have.

FISCAL YEAR 2012 BUDGET REQUEST—DETAILED SUMMARY

SCIENCE

The President's fiscal year 2012 request for NASA includes $5,016.8 million for Science. NASA continues to expand humanity's understanding of our Earth, our Sun, the solar system, and the universe with 56 science missions in operation and 28 more in various stages of development. The Science budget funds these missions as well as the research of more than 3,000 scientists, engineers, technologists, and their students across the Nation. NASA is guided in setting its priorities for strategic science missions by the recommendations of the NRC decadal surveys. The agency selects competed missions and research proposals based on open competition and peer review. NASA's science efforts continue to advance a robust and scientifically productive program while making difficult choices commensurate with the Government-wide priority to constrain the Federal budget.

The fiscal year 2012 budget request includes $1,797.4 million for Earth science. NASA's constellation of Earth-observing satellites provides much of the global environmental observations used for climate research in the United States and abroad.

In early fiscal year 2012, NASA plans to launch the National Polar-orbiting Operational Environmental Satellite System (NPOESS) Preparatory Project (NPP), continuing selected climate data records and becoming an integral part of the Nation's operational meteorological satellite system for weather prediction. We also plan to select new Venture Class science instruments and small missions in fiscal year 2012. The Glory mission to be launched later this week will release its first global set of calibrated and validated aerosol measurements in fiscal year 2012. In addition, we will produce the first fusion data products integrating Glory data with measurements from the rest of the A-Train (a formation of Earth-monitoring satellites that employ multiple scientific instruments to observe the same path of Earth's atmosphere and surface at a broad swath of wavelengths).

The Aquarius instrument on the Argentine Satélite de Aplicaciones Científicas (SAC)–D mission (launching later this year) will deliver the first global ocean salinity measurements to the science community in fiscal year 2012. OCO–2, Landsat Data Continuity Mission, and the Global Precipitation Measurement missions will

be in integration and testing in fiscal year 2012. The first two NRC Decadal Survey missions, Soil Moisture Active/Passive and the Ice, Cloud, and land Elevation Satellite-2 (ICESat-2), will both enter into development during fiscal year 2012. This budget request also funds robust Research and Analysis, Applied Science, and Technology programs. In this climate of fiscal austerity there are some important capabilities that will not be developed in order to keep others on track in more constrained future years. Development of the second two Tier 1 Decadal Survey missions, the Deformation, Ecosystem Structure, and Dynamics of Ice (DESDynI), and the Climate Absolute Radiance and Refractivity Observatory (CLARREO), has been deferred resulting in launch dates no earlier than 2020. NASA will continue preformulation work on the DESDynI and review international partner options. However, the fiscal year 2012 request enables the Gravity Recovery and Climate Experiment Follow-on (GRACE–FO), the Pre-Aerosols-Clouds-Ecosystems (PACE), and the Tier 2 missions Surface Water and Ocean Topography (SWOT), and Active Sensing of CO_2 Emissions Over Nights, Days, and Seasons (ASCENDS) to go forward as planned.

The Science budget request includes $1,540.7 million for planetary science in fiscal year 2012. NASA and its partners consider the period from October 2010 to August 2012 (the length of a Martian year) to be the "Year of the Solar System."

The Juno mission will launch in August 2011 and arrive at Jupiter in 2016. The Gravity Recovery and Interior Laboratory (GRAIL) mission, following launch in September 2011, will enter lunar orbit and help determine the structure of the lunar interior from crust to core; the mission will advance our understanding of the thermal evolution of the Moon by the end of its prime mission in fiscal year 2012. A newly installed Web cam is giving the public an opportunity to watch technicians assemble and test NASA's MSL "Curiosity," one of the most technologically advanced interplanetary missions ever designed. More than 1 million people have watched assembly and testing of Curiosity via a live Web cam since it went online in October. Curiosity will launch in early fiscal year 2012 and arrive at Mars in August 2012; it will be two times as large and three times as heavy as the Spirit and Opportunity rovers, and will focus on investigating whether conditions on Mars have been favorable for microbial life and for preserving clues in the rocks about possible past life. The MErcury Surface, Space ENvironment, GEochemistry and Ranging (MESSENGER) spacecraft will arrive at Mercury later this month and will complete its first year in Mercury orbit in March 2012. MESSENGER's instruments will map nearly the entire planet in color, image the surface in high resolution and measure the composition of the surface, atmosphere and nature of the magnetic field and magnetosphere. During its nearly decade-long mission, the Dawn mission will study the asteroid Vesta and dwarf planet Ceres—celestial bodies believed to have accreted early in the history of the solar system. Dawn will enter into orbit around Vesta this summer and will depart in 2012 for its encounter with Ceres in 2015. NASA and the European Space Agency (ESA) have selected the five science instruments for the 2016 ExoMars Trace Gas Orbiter mission. The budget also supports robust Research and Analysis and Technology programs. NASA is expecting the results from the next National Academy of Sciences Decadal Survey for Planetary Science later this month. NASA will use this survey to prioritize ongoing programs and future mission opportunities.

The fiscal year 2012 budget request includes $682.7 million for Astrophysics (not including an additional $375 million for the James Webb Space Telescope (JWST) which is detailed below). This is a golden age of space-based Astrophysics, with 14 observatories in operation. Astrophysics research, technology investments, and missions aim to understand how the universe works, how galaxies, stars and planets originated and developed over cosmic time, and whether Earth-like planets and life exist elsewhere in the cosmos.

The fiscal year 2012 budget request reflects the scientific priorities of the new National Academy of Science Decadal Survey entitled, "New Worlds, New Horizons in Astronomy and Astrophysics". The budget includes additional funding for the Explorer mission selection planned for 2012, sustains a vigorous flight rate of future astrophysics Explorer missions and missions of opportunity, and increases investments in recommended research and technology initiatives. Funding is also provided for pre-formulation investments in recommended large missions beyond JWST, while work on the Space Interferometry Mission (SIM) and Joint Dark Energy Mission (JDEM) has been brought to a close, consistent with the recommended Decadal Survey program. SOFIA will complete its open-door flight testing and conduct the first competed science observations in fiscal year 2012. The NuSTAR mission will launch in early 2012. The NASA Astrophysics budget also supports continuing operations of Hubble, Chandra, and several other astrophysics observatories in space. The budget increases funding for the core Astrophysics research program, including

sounding rocket and balloon suborbital payloads, theory, and laboratory astrophysics.

The fiscal year 2012 budget request includes $375 million for the JWST. JWST is now budgeted as a separate theme, reflecting changes implemented in fiscal year 2011 to improve management oversight and control over this critical project, as recommended by the Independent Comprehensive Review Panel's (ICRP) report in November 2010. The project, previously managed within the Astrophysics Division, is now managed by a separate program office at NASA headquarters. Management of this JWST organization at headquarters now reports directly to the NASA Associate Administrator and the Associate Administrator for Science. The Goddard Space Flight Center has implemented analogous changes, with JWST project management now reporting directly to the Center Director. JWST was the top-priority large mission recommended in the previous NRC Decadal Survey and is considered a foundational element of the science strategy in the new Decadal Survey for Astronomy and Astrophysics. During 2010, JWST completed its most significant mission milestone to date, the Mission Critical Design Review. Cost growth and schedule issues identified following this milestone led to the formation of the ICRP. The ICRP report concluded that the problems causing cost growth and schedule delays on the JWST project are associated with cost estimation and program management, not technical performance. The $375 million funding in 2012 gives the program a stable footing to continue progress while the agency develops a revised program plan that includes a realistic assessment of schedule and life-cycle cost. The revised schedule and life-cycle cost will be reflected in the 2013 budget request.

The fiscal year 2012 budget request includes $622.3 million for heliophysics. NASA's heliophysics satellites provide not only a steady stream of scientific data for NASA's research program, but also supply a significant fraction of critical space weather data used by other Government agencies for support of commercial and national security activities in space. Those agencies use the data to protect operating satellites, communications, aviation and navigation systems, as well as electrical power transmission grids. The spacecraft also provides images of the Sun with 10 times greater resolution than high-definition television in a broad range of ultraviolet wavelengths. On February 6, 2011, the two STEREO spacecraft reached 180 degrees separation; when combined with SDO, these spacecraft will enable constant imaging of the full solar sphere for the next 8 years, as the solar cycle peaks and begins to decline again. These three spacecraft working together and in combination with NASA's other solar observatories will give us unprecedented insight into the Sun and its dangerous solar storms that could threaten both satellites and humans in space as well as electric power systems on Earth. NASA has begun development of a mission, called Solar Probe Plus, that will visit and study the Sun from within its corona—a distance only 8.5 solar radii above its surface.

The fiscal year 2012 budget will enable completion of the Radiation Belt Storm Probes mission for launch in fiscal year 2012 as well as the completion of development of the Interface Region Imaging Spectrograph (IRIS) Explorer mission. In fiscal year 2012, the Magnetospheric Multiscale (MMS) mission will enter its assembly and integration phase, the Solar Orbiter Collaboration with ESA will undergo Mission Confirmation Review, and the Solar Probe Plus mission will enter into the preliminary design phase. NASA has increased funding for the next Explorer mission selection planned for 2012 to enable selection of up to two full missions, as well as instruments that may fly on non-Explorer spacecraft. The budget also supports robust Research and Analysis and Sounding Rocket operations programs. The National Academy of Sciences has begun work on the next Decadal Survey for heliophysics and we anticipate its release in the spring of 2012.

AERONAUTICS RESEARCH

The fiscal year 2012 budget request for Aeronautics is $569.4 million. As an industry, aviation contributes $1.3 trillion to the Nation's economy and employs more than 1 million people. Airlines in the United States transport more than 1 million people daily, but during peak travel times the air traffic and airport systems in the United States are stretched to capacity. Environmental concerns, such as aircraft noise and emissions, limit increased operations and the expansion of airports and runways. In response to these challenges, the Nation is pursuing the realization of the Next Generation Air Transportation System (NextGen). NextGen will accommodate more aircraft operating within the same airspace, including aircraft with widely varying performance characteristics. The President recently challenged the Nation to increase its competitiveness in advanced technologies. NASA meets this challenge with aeronautics research to create the safer, more fuel-efficient, quieter, and

environmentally responsible aircraft and air traffic management procedures needed to make NextGen a reality.

—The Aviation Safety Program conducts research to ensure that current and new aircraft and operational procedures maintain the high level of safety which the American public has come to count on, even as aviation systems become more complex. Last year, the program published guidelines on automation, displays, and alerting technologies for future aircraft cockpit designs based on data collected from real flight crews during simulations of high-air-traffic-density operations. Further increases in air traffic will require even higher levels of automation without sacrificing safety. NASA is addressing this need by developing new methods to verify and validate complex aircraft and air traffic control systems and further developing human performance models to be applied in the design of automated systems. The program is also developing data mining methods that will enable the discovery of safety issues through automated analysis of the vast amounts of data generated during flight operations. These methods will enable a new, proactive approach to aircraft maintenance and design to avoid the occurrence of safety issues, rather than a reactive approach after a safety-related incident occurs.

—Reductions in environmental impact will be achieved not only through new aircraft, engines, and fuels, but also through improved air traffic management procedures. The Airspace Systems Program is developing these procedures in order to provide the flexibility needed to add capacity to the system as air travel demands increase. Last year, we partnered with the Federal Aviation Administration (FAA), Boeing, Sensis, United Airlines, and Continental Airlines to complete joint simulations of new Efficient Descent Advisor (EDA) procedures, and in fiscal year 2012, the program will deliver documentation of the results to the FAA. EDA procedures are a key component of the FAA's 3D-Path Arrival Management program and NextGen and can save hundreds of pounds of fuel and carbon dioxide emissions per participating flight, while reducing noise over surrounding communities. In fiscal year 2012, we will also accelerate field trials of new procedures enabled by Automatic Dependent Surveillance-Broadcast (ADS–B) technology. This effort will demonstrate near-term and mid-term ADS–B application benefits and provide airlines with data to support their strategic decisions related to the significant investments they need to make to equip their aircraft with ADS–B capability.

—The Fundamental Aeronautics Program seeks to continually improve technology that can be infused into today's state-of-the-art aircraft, while enabling game-changing new concepts, such as Hybrid Wing Body (HWB) airframes, tilt-rotor aircraft, low-boom supersonic aircraft, and sustained hypersonic flight. In fiscal year 2012, the program will accelerate research on a number of key enabling technologies identified through four conceptual design studies completed last year in collaboration with industry and academia. The program will also expand the measurement of emissions generated when using nonpetroleum alternative aircraft fuels. In fiscal year 2012, we will develop instrumentation and operating procedures in preparation for a flight test campaign using the NASA DC–8 aircraft operating at relevant altitudes and cruise speeds. This will provide the first-ever data to improve our understanding of alternative fuel impact on contrail formation, an important factor in aviation climate impact.

—The Integrated Systems Research Program evaluates and selects the most promising "environmentally friendly" engine and airframe concepts emerging from the fundamental research programs for further development, integration, and evaluation in relevant environments. Last year, we completed the last of 80 flights to explore the stability and control characteristics of the sub-scale X–48B HWB aircraft. In fiscal year 2012, we will conduct the first-ever testing of a Hybrid Wing Body noncircular fuselage section fabricated using a new low-weight, damage-tolerant concept for composite aircraft structures. Beginning this year, the program is also addressing the growing requirement to integrate unmanned aircraft systems (UAS) into the national airspace system. Current FAA regulations are built upon the condition of a pilot being on-board the aircraft. The program will therefore generate data for FAA use in rule-making through development, testing, and evaluation of UAS technologies in operationally relevant scenarios.

—U.S. leadership in aerospace depends on ready access to technologically advanced, efficient, and affordable aeronautics test capabilities. NASA's Aeronautics Test Program makes strategic investments to ensure the availability of these ground test facilities and flight test assets to researchers in Government, industry, and academia. In addition to this strategic management activity, the program will continue with the development of new test instrumentation and

test technologies. The program is modifying a Gulfstream III business jet in order to flight test a new approach to reducing drag on an aircraft by adding carefully engineered surface roughness to the wings. This new flight-test capability will enable us to test this drag reduction concept for the first time at the altitudes and speeds at which commercial aircraft typically cruise.

NASA cannot do all of these good things alone. Our partnerships with industry, academia, and other Federal agencies are critical to our ability to expand the boundaries of aeronautical knowledge for the benefit of the Nation. These partnerships foster a collaborative research environment in which ideas and knowledge are exchanged across all communities and help ensure the future competitiveness of the Nation's aviation industry. They also directly connect students with NASA researchers and our industrial partners and help to inspire students to choose a career in the aerospace industry.

SPACE TECHNOLOGY

The fiscal year 2012 budget request includes $1,024.2 million for space technology, consistent with the NASA Authorization Act of 2010 and the administration's priorities on Federal investments in research, technology and innovation across the Nation. Within the fiscal year 2012 request, NASA has integrated management responsibility for two technology development programs reflected in the NASA Authorization Act within the Office of the Chief Technologist. In fiscal year 2012, Space Technology includes funding for long-standing Small Business Innovation Research and Small Business Technology Transfer programs (SBIR and STTR), as well as technology transfer and commercialization efforts, the crosscutting space technology programs formulated in fiscal year 2011, and the exploration technology programs that are being transferred into this account. All of the space technology programs have deep roots in technology development approaches NASA has pursued in previous years.

NASA technology development activities under space technology will transform the Nation's capabilities for exploring space. Through this effort, NASA advances crosscutting and exploration-specific technology, performs technology transfer and technology commercialization activities, develops technology partnerships with other Government agencies, and coordinates the agency's overall technology investment portfolio. The Office of the Chief Technologist (OCT) manages space technology.

Space Technology is the central NASA contribution to the President's revitalized research, technology, and innovation agenda for the Nation. NASA's space technology portfolio responds with investments that reach all corners of the Nation—wherever there are innovative ideas and technical challenges to be solved. Advanced technologies are required to enable NASA's future science, aeronautics, and exploration missions. As demonstrated over many years, these same advanced technologies find their way into products and services available every day to the public. NASA's space technology is an innovation engine, investing in the innovative, high-payoff ideas, and technologies of tomorrow that industry cannot tackle today. This unique work attracts bright minds into educational and career paths in STEM disciplines and enhances the Nation's technological leadership position in the world. Through these technological investments, NASA and our Nation will remain at the cutting-edge.

In fiscal year 2010 and the first quarter of fiscal year 2011, NASA focused on planning, formulating, and implementing the space technology project elements. The agency received 1,400 responses to six Space Technology Requests For Information (RFIs) released during fiscal year 2010. These inputs were invaluable in finalizing future space technology solicitations and demonstrate a strong interest in, and need for, significant NASA investment in space research and technology. NASA released solicitations for the ongoing flight opportunities and SBIR/STTR programs. In December 2010, NASA released the inaugural Space Technology Graduate Fellowships call. In March 2011, consistent with provisions of the NASA Authorization Act, the agency released three additional high-priority solicitations spanning space technology's strategic investment areas. NASA also recently developed a draft set of 14 space technology roadmaps, which define pathways to advance the Nation's capabilities in space and establish a mechanism for prioritization of NASA's technology investments. Consistent with the NASA Authorization Act of 2010, NASA's space technology roadmaps are being evaluated and improved through a community-engaged review process managed by the NRC that will produce a range of pathways and recommended priorities that advance the Nation's space capabilities. An interim NRC report is expected in fiscal year 2011, and the final report is expected in the first quarter of fiscal year 2012.

NASA's Partnership Development and Strategic Integration activities develop key space technology partnerships and guide NASA's space technology investment decisions. OCT provides a primary entry point to industry and Government agencies for technology transfer and commercialization, interagency coordination and joint activities, intellectual property management, and partnership opportunities. OCT is also responsible for development of an agency technology portfolio and coordination of the agency technology investments through center and mission directorate technology councils and through the space technology roadmaps to ensure that space technology investments serve NASA's missions as well as the interests of other Government agencies and the Nation's aerospace industry.

The agency's space technology investments include the Small Business Innovation Research and the Small Business Technology Transfer programs (SBIR and STTR). Small businesses have generated 64 percent of net new jobs over the past 15 years. NASA invests at least 2.5 percent of its extramural research and development in the SBIR program. The STTR program makes awards to small businesses for contracts for cooperative research and development with nonprofit research institutions, such as universities. For STTR, NASA's investment exceeds 0.3 percent of its extramural research and development. For fiscal year 2012, higher maximum awards for SBIRs are allowed, with Phase I awards that can reach $150,000 and, for Phase II, up to $1 million. Also in fiscal year 2012, NASA is considering approaches to align the SBIR and STTR topics with space technology roadmaps and the National Aeronautics Research and Development Plan, while coordinating with centers and maintaining a mission directorate steering council to continue to improve our rate of mission infusion. The fiscal year 2012 request includes $284 million for the SBIR/STTR program and related technology transfer and commercialization activities, funded in fiscal year 2010 and earlier through NASA's Innovative Partnership Program.

Crosscutting Space Technology Development (CSTD) activities invest in broadly applicable technologies through early stage conceptual studies, ground-based and laboratory testing, relevant-environment flight demonstrations, and technology test beds, including the ISS. The NASA Mission Directorates, other Government agencies, and industry are the ultimate customers for Crosscutting Space Technology Development products. Within this element, there are three investment areas:

—Early stage innovation;

—Game-changing technology; and

—Crosscutting capability demonstrations.

Early Stage Innovation funds space technology research grants and fellowships to accelerate space technology development through innovative projects with high risk/high payoff. It also funds the NASA Innovative Advanced Concepts (NIAC) effort, which studies the viability and feasibility of space architecture, system, or mission concepts. It includes the Center Innovation Fund to stimulate and encourage creativity and innovation within the NASA Centers, and provides the prizes for the Centennial Challenges competitions that seek innovative solutions to technical problems in aerospace technology. Through ground-based and laboratory testing, game changing technology proves the fundamental physical principles of those technologies that can provide transformative capabilities for scientific discovery, and human and robotic exploration. Specifically for small satellites, the Franklin subsystem technology development activity matures subsystem technology in laboratory environments. Crosscutting capability demonstrations proves the most promising technological solutions in the relevant environment of space. Technology demonstration missions prove larger-scale system technologies in the space environment, whereas the Edison small satellite missions demonstrate the utility of these innovative space platforms for NASA's future missions. Flight opportunities utilizes the capabilities of the commercial reusable suborbital space transportation and parabolic flight services industries to test technologies. Seventy percent of the CSTD funds will be awarded competitively, with solicitations open to the broad aerospace community to ensure engagement with the best sources of new and innovative technology. Industry, academia and the NASA Centers will participate in the development of CSTD products.

In fiscal year 2012, CSTD will engage hundreds of graduate students and researchers through grants and fellowships, initiate dozens of ground and flight technology demonstrations, initiate multiple technology studies, and formulate its first demonstration missions. The fiscal year 2012 request includes $430 million for crosscutting space technology development activities. By focusing on broadly applicable, high-payoff, transformative technology that industry cannot tackle today, NASA's crosscutting space technology development activities mature the technology required for NASA's future missions in science and exploration while proving the capabilities and lowering the cost of other government agencies and commercial space activities. These investments are critical for the agency's future, our Nation's

future in space, and our Nation's technological leadership position in the world. By attacking these technological challenges immediately, NASA can build the capabilities required for its future missions and serve as a catalyst in America's economic recovery while increasing the Nation's global technological leadership position. As noted by NRC in numerous reports, NASA needs to make maturing visionary, far-reaching concepts and technologies a high priority if we are to have advanced concepts available in the future.

The fiscal year 2012 request transfers management authority for $310 million (from a total of $437 million) of exploration technology development activities to OCT. The fiscal year 2012 requested Exploration Technology Development (ETD) level is equivalent to the budget for these activities in fiscal year 2012 in the authorization act. For traceability, the transferred activities have been consolidated in a specific budget line within space technology—ETD. NASA plans to capitalize on technical synergies in the project elements from crosscutting space technology development and exploration technology development by managing these programs in an integrated manner. Technologies within ETD enable NASA to conduct future human missions beyond LEO with new capabilities that have greater affordability. Technologies for future human exploration missions are matured through ground-based and laboratory testing, relevant environment flight demonstrations, and technology test beds, including the ISS. These technologies may then be designed into future NASA human exploration missions with acceptable levels of risk. ESMD will continue to set the prioritized requirements for ETD efforts and will serve as the primary customer for these mission-focused ETD products. In addition to ongoing-guided Exploration-specific technology development activities, in fiscal year 2012, NASA will use 30 percent of the funds within this account to fund competitive awards, drawing proposals from industry, academia, and the NASA Centers for innovative exploration-specific technologies and demonstration missions.

EXPLORATION

The fiscal year 2012 budget request for exploration is $3,948.7 million. In fiscal year 2012 and beyond, NASA's exploration programs will continue to support the U.S. economy by enabling safe, reliable, and cost effective U.S.-provided commercial access to LEO for crew and cargo as soon as possible. Included in this budget request is funding for three new, robust categories or "themes" that will expand the capabilities of future space explorers far beyond those we have today:

—Human Exploration Capabilities;

—Commercial Spaceflight; and

—Exploration Research and Development.

These systems and capabilities include launch and crew vehicles for missions beyond LEO—the Moon, asteroids, and eventually Mars, affordable commercial crew access to the ISS, and technologies and countermeasures to keep astronauts healthy and productive during deep space missions, and to reduce the launch mass and cost of deep space missions.

The fiscal year 2012 budget request includes $2,810.2 million for Human Exploration Capability (HEC). HEC is the successor to the constellation systems theme; programs and projects under HEC will develop the launch vehicles and spacecraft that will provide the initial capability for crewed exploration missions beyond LEO. In particular, HEC's SLS program will develop the heavy-lift vehicle that will launch the crew vehicle, other modules, and cargo for these missions. The MPCV program will develop the vehicle that will carry the crew to orbit, provide emergency abort capability, sustain the crew while in space, and provide safe re-entry from deep-space return velocities. NASA is currently developing plans for implementing the SLS and MPCV programs, including efforts to transition the design and developmental activities of the Constellation program. A major element of the transition involves shifting design and developmental efforts away from a closely coupled system (Ares I and Orion) to a more general launch vehicle (SLS) and crew vehicle (MPCV).

Consistent with direction in the NASA Authorization Act of 2010, the agency has developed a reference vehicle design for the SLS that is derived from Ares and space shuttle hardware. The current concept vehicles would utilize a liquid oxygen/liquid hydrogen core with five RS–25 Space Shuttle Main Engine (SSME)-derived engines, five-segment solid rocket boosters, and a J–2X-based upper stage rocket for the SLS. This would allow for use of existing shuttle and Ares hardware assets in the near term, with the opportunity for upgrades and/or competition downstream for eventual upgrades in designs needed for affordable production. For the MPCV, NASA has chosen the beyond-LEO design of the Orion Crew Exploration Vehicle as the reference vehicle design for the MPCV. The Orion development effort has already benefited from significant investments and progress to date, and the Orion requirements

closely match MPCV requirements as defined in the authorization act, which include utilizing the MPCV for beyond-LEO crew transportation and as backup for ISS crew transportation.

NASA will evaluate the reference vehicle designs this spring and incorporate results of industry studies that the agency solicited earlier this fiscal year. In particular, one of the greatest challenges for NASA is to reduce the development and operating costs for human spaceflight missions to sustain a long-term U.S. human spaceflight program. We must plan and implement an exploration enterprise with costs that are credible, sustainable, and affordable for the long term under constrained budget environments. As such, our development efforts will be dependent on sufficiently stable funding over the long term, coupled with a successful effort on the part of NASA and the eventual industry team to reduce costs and to establish stable, tightly managed requirements.

NASA plans to approach affordability comprehensively in pursuit of exploration beyond LEO to increase the probability that key elements are developed and missions can occur within a realistic budget profile. For all development activities, we will emphasize innovative acquisition and program management approaches, including risk management, to reduce recurring and operations costs. In doing so, plans for bringing the MPCV and SLS vehicles online with lower costs will be as credible and realistic as possible, and significant efforts will be made to ensure cost risks will be well understood. Overall, NASA's designs and acquisition strategies for the MPCV and SLS programs will not be solidified until all of the pertinent knowledge on cost and safety is obtained to ensure an affordable and executable solution. NASA expects to finalize acquisition strategies this summer, and will obtain independent, external assessments of cost and schedule for SLS and MPCV design options during the spring or summer timeframe. We will share this information with the Congress—including members of this subcommittee—as soon as we are able to do so.

The fiscal year 2012 budget request includes $850 million for the commercial spaceflight theme in exploration. This effort will provide incentives for commercial providers to develop and operate safe, reliable, and affordable commercial systems to transport crew and cargo to and from the ISS and LEO. This approach will provide assured access to the ISS, strengthen America's space industry, and provide a catalyst for future business ventures to capitalize on affordable access to space. A vibrant commercial space industry will add well-paying, high-tech jobs to the U.S. economy, and will reduce America's reliance on foreign systems.

In 2010, NASA further expanded its successful Commercial Crew Development (CCDev) program by initiating CCDev2 in October 2010. In doing so, we solicited proposals to further advance commercial crew transportation system concepts and mature the design and development of system elements, such as launch vehicles and spacecraft. Depending on available funding in fiscal year 2011, we expect to select a series of CCDev2 proposals for award early this year. Once finalized, the resulting CCDev2 agreements should result in significant maturation of commercial crew transportation system capabilities, with consideration given to NASA's draft human certification requirements and standards or the industry equivalent to those requirements and standards.

Beginning in fiscal year 2012, NASA proposes to take the accomplishments and lessons learned from the successes of the first two rounds of CCDev and incorporate them into a new initiative called CCDev3. This initiative will facilitate the development of a U.S. commercial crew space transportation capability with the goal of achieving safe, reliable and cost effective access to and from LEO and the ISS. Once the commercial crew transportation capability is matured and available to customers, NASA plans to purchase transportation services to meet its ISS crew rotation and emergency return obligations.

For CCDev3, NASA plans to award competitive, pre-negotiated, milestone-based agreements that support the development, testing, and demonstration of multiple commercial crew systems. The acquisition strategy for CCDev3 is still in development, but it will feature pay-for-performance milestones, a fixed Government investment, the use of negotiated service goals instead of detailed design requirements, and a requirement for private capital investment.

In calendar year 2011 work on NASA's Commercial Orbital Transportation Services (COTS) program will continue under the commercial spaceflight theme, using previous-year funding. Both of NASA's funded COTS partners continue to make progress in developing their cargo transportation systems, based in part on NASA's financial and technical assistance. In particular, on December 8, 2010, Space Exploration Technologies (SpaceX) successfully launched its Falcon 9 vehicle, and demonstrated separation of the Dragon spacecraft and completion of two full orbits, orbital maneuvering and control, re-entry, parachute descent, and spacecraft recovery

after splashdown in the Pacific Ocean. For its part in COTS, NASA's second funded partner, Orbital Sciences Corporation, recently began integration and testing of its Cygnus Service Module and Taurus II launch vehicle. Both companies are expected to complete their remaining COTS demonstration flights in late 2011 or early 2012.

The fiscal year 2012 budget request for ESMD includes $288.5 million for ERD. The ERD theme will expand fundamental knowledge that is key to human space exploration, and will develop advanced exploration systems that will enable humans to explore space in a more sustainable and affordable way. ERD will be comprised of the Human Research Program (HRP) and the Advanced Exploration Systems (AES) program, which will provide the knowledge and advanced human spaceflight capabilities required to implement the U.S. Space Exploration Policy.

In fiscal year 2012, HRP and its associated projects will continue to develop technologies, countermeasures, diagnostics, and design tools to keep crews safe and productive on long-duration space missions. As astronauts journey beyond LEO, they will be exposed to microgravity, radiation, and isolation for long periods of time. Keeping crews healthy and productive during long missions will require new technologies and capabilities. Therefore, continued research is required to study how the space environment, close quarters, heavy workloads, and prolonged time away from home contribute to stress, and then develop technologies that can prevent or mitigate these effects. More specifically, in fiscal year 2012, HRP will support approximately 15–20 biomedical flight experiments on the ISS and deliver the next-generation space biomedical ultrasound device to enhance the station's human research facility capability. Other activities will include development of a training program for ultrasound diagnosis of fractures and the evaluation of blood analysis technology for astronaut health monitoring. Additionally, HRP projects will deliver an enhanced design tool for vehicle radiation shielding assessments and release the second version of an acute radiation risk model. In the area of behavioral health and performance, researchers will complete a sleep-wake actigraphy report on the ISS crew. In order to support its research requirements, HRP will release two NASA Research Announcements addressing space radiation health risks and human physiological changes associated with spaceflight.

AES will continue projects from the exploration technology development program that are close to application and closely tied to human safety in space. In fiscal year 2012, AES will assume responsibility for developing and demonstrating innovative prototype systems to provide basic needs such as oxygen, water, food, and shelter that can operate dependably for at least a year. AES will demonstrate these systems in ground test beds, Earth-based field and underwater tests, and ISS flight experiments. In fiscal year 2012, AES will use a ground test bed to demonstrate the reliability of life support system components, and a portable life support system for an advanced space suit will be tested in a vacuum chamber. Ground-based analog field tests and underwater tests will validate a prototype Deep Space Habitat, where the crew will live during transit on long missions, and a space exploration vehicle that will allow the crew to closely approach an asteroid, explore its surface, and conduct surface exploration outside the vehicle. AES plans to use innovative approaches for the rapid development of system concepts, such as small, focused teams of NASA engineers and technologists working with industry partners to gain hands-on experience. AES will pilot these processes to improve the affordability of future exploration programs.

SPACE OPERATIONS

The fiscal year 2012 budget request includes $4,346.9 million for space operations, funding the space shuttle program retirement, the ISS program, and the space and flight support program.

The fiscal year 2012 budget request for the space shuttle program is $664.9 million. In 2011, the shuttle is slated to fly out its remaining missions. On February 24, *Discovery* launched on mission STS–133, carrying supplies to ISS, as well as the permanent Multi-purpose Module (PMM), a Multi-Purpose Logistics Module (MPLM) transformed to remain on orbit, expanding the station's storage volume. In April 2011, *Endeavour*, STS–134, will carry the Alpha Magnetic Spectrometer (AMS) and attach it to the ISS' truss structure. The final shuttle mission, STS–135, is targeted for late June of this year, if funding is available. During the mission, *Atlantis* will deliver critical supplies to the ISS and recover and return to Earth an ammonia coolant pump module that failed on the station last year.

Following the completion of the remaining missions in 2011, the space shuttle program will focus on transition, retirement, and disposition of program assets and workforce. Approximately 1.2 million line items of personal property (e.g., equipment) are associated with the space shuttle program, with about 500,000 of these

line items associated with the space shuttle propulsion system elements (the reusable solid rocket motor, the solid rocket booster, the external tank, and space shuttle main engines). As part of this effort, NASA will assess space shuttle property (including main propulsion system elements) applicability to the SLS.

On April 12, 2011, we will celebrate the 50th anniversary of human spaceflight, and the 30th anniversary of the first flight of space shuttle *Columbia* on STS–1. NASA recognizes the role the space shuttle vehicles and personnel have played in the history of space activity, and looks forward to transitioning key workforce, technology, facilities, and operational experience to a new generation of human spaceflight exploration activities.

The fiscal year 2012 budget request includes funding for Space Program Operations Contract (SPOC) pension liability. The United Space Alliance (USA) notified NASA of its desire to terminate all defined pension benefit plans as of December 31, 2010. USA has consistently incorporated and billed the maximum allowable costs into their indirect rates, but the recent deterioration of the equities and credit markets has caused their plan to be underfunded by an estimated $500–$600 million. SPOC, which accounts for almost all of USA's business base, is a cost-type contract covered by the Cost Accounting Standards (CAS). These standards stipulate that any costs of terminating plans are a contractual obligation of the Government (if deemed allowable, allocable, and reasonable). NASA and USA entered into an agreement under which USA froze their pension plans as of December 31, 2010 and deferred any decision about terminating their plan until after December 31, 2011, allowing NASA to address this issue, if it arises, with fiscal year 2012 funds, if appropriated. USA and NASA have instituted a working group to discuss pension termination options and have met with the Pension Benefit Guaranty Corporation to discuss potential options. If funding remains after the pension plan termination, it will be used to defray space shuttle closeout costs that would otherwise require fiscal year 2013 funding. If there is a shortfall, it will reduce available space shuttle funds for closeout and some activity could move later than planned. We will keep the Congress informed as this issue evolves.

The fiscal year 2012 budget request for the ISS program is $2,841.5 million, of which $1,656 million is for operations, research, and utilization, and $1,186 million for crew and cargo transportation. The ISS has transitioned from the construction era to that of operations and research, with a six-person permanent crew, three major science labs, an operational lifetime through at least 2020, and a growing complement of cargo vehicles, including the European Automated Transfer Vehicle and the Japanese H–II Transfer Vehicle. The fiscal year 2012 budget request reflects the importance of this unparalleled research asset to America's human spaceflight program.

In addition to conducting research in support of future human missions into deep space, astronauts aboard the ISS will carry out experiments anticipated to have terrestrial applications in areas such as biotechnology, bioengineering, medicine, and therapeutic treatment as part of the National Laboratory function of the station. In support of this effort, NASA has recently released a Cooperative Agreement Notice for an independent nonprofit organization to manage the multidisciplinary research carried out by NASA's National Laboratory partners. This organization will:

—act as a single entry point for non-NASA users to interface efficiently with the ISS;

—assist researchers in developing experiments, meeting safety and integration rules, and act as an ombudsman on behalf of researchers;

—perform outreach to researchers and disseminate the results of ISS research activities; and

—provide easily accessed communication materials with details about laboratory facilities, available research hardware, resource constraints, and more.

The fiscal year 2012 budget request for ISS reflects increased funding for the transportation required to support this research.

The ISS transportation budget also supports NASA's continued use of the Russian Soyuz spacecraft for crew transportation and rescue services, pending the availability of a domestic crew transportation system, as well as U.S. commercial cargo transportation. The ISS transportation budget supports NASA's Cargo Resupply Services suppliers as they continue to make progress toward fielding their cargo resupply vehicles, which will be critical to the maintenance of ISS after the retirement of the space shuttle. We anticipate that the first commercial resupply flight will take place by the end of this year, and that both providers will have their systems operational in 2012.

The fiscal year 2012 budget request for Space and Flight Support (SFS) is $840.6 million. The budget request provides for critical infrastructure indispensable to the Nation's access to and use of space, including Space Communications and Naviga-

tion (SCaN); Launch Services Program (LSP); Rocket Propulsion Test (RPT); and Human Space Flight Operations (HSFO). The SFS budget also includes investment in the 21st Century Space Launch Complex, intended to meet the infrastructure requirements of the SLS, MPCV, and commercial cargo/launch services providers. It will increase operational efficiency and reduce launch costs by modernizing the Florida launch capabilities for a variety of NASA missions, which will also benefit non-NASA users.

In fiscal year 2012, the SCaN program will continue to improve the robustness of the Deep Space Network (DSN) through its efforts to replace the aging 70m antenna capability with 34m antennae, launch Tracking and Data Relay Satellite (TDRS)-K and continue the development of TDRS—L. In the area of technology, we will conduct on-orbit tests using the Communication Navigation and Networking Reconfigurable Test bed (CoNNeCT), integrate the optical communications system on the Lunar Atmosphere and Dust Environment Explorer (LADEE) spacecraft, and begin operational space mission use of Disruption Tolerant Networking communications. The SCaN operational networks will continue to provide communications and tracking services to more than 75 spacecraft and launch vehicles during fiscal year 2012. LSP has several planned NASA launches in fiscal year 2012 including the NPOESS Preparatory Project (NPP), MSL, Nuclear Spectroscopic Telescope Array (NuSTAR), TDRS–K, and RBSP, and will continue to provide support for the development and certification of emerging launch services. The RPT program will continue to provide test facility management, and provide maintenance, sustaining engineering, operations, and facility modernization projects necessary to keep the test-related facilities in the appropriate state of operational readiness. HSFO includes Crew Health and Safety (CHS) and Space Flight Crew Operations (SFCO). SFCO will continue to provide trained crew for ISS long-duration crew rotation missions. CHS will identify and deliver necessary core medical capabilities for astronauts. In addition, CHS will gather astronaut medical data critical for determining medical risk as a result of spaceflight and how best to mitigate that risk. NASA has enlisted the NRC to conduct an independent study of the activities funded within NASA's HSFO program, focusing on the role, size, and training requirements of the human spaceflight office after space shuttle retirement and space station assembly completion.

The fiscal year 2012 budget request also establishes a new line item called Mission Operations Sustainment, which will address future space operations functions essential to NASA's human spaceflight mission, including funding to purchase U.S. commercial crew transportation services to and from ISS once they are developed, and key ground and space infrastructure improvements required by the Space Network (SN) in order to accommodate anticipated demand in the out years; the Mission Operations Sustainment budget would be utilized to fund this performance gap. Although the exact amount of funding required for these needs is unknown, it is clear that NASA's human spaceflight mission cannot be sustained without resources provided by Missions Operations Sustainment beyond fiscal year 2012. The agency will perform the requisite technical and program analysis and planning, and the results will be reflected in the fiscal year 2013 budget request.

EDUCATION

The fiscal year 2012 budget request for education is $138.4 million. This budget request furthers NASA's commitment to inspiring the next generation of explorers in the science, technology, engineering, and mathematics (STEM) disciplines. In fiscal year 2012, NASA will continue to strongly support the administration's STEM priorities and to capitalize on the excitement of NASA's mission to stimulate innovative solutions, approaches, and tools that inspire student and educator interest and proficiency in STEM disciplines. The agency's education strategy will increase its impact on STEM education by further focusing K–12 efforts on middle-school pre- and in-service educator professional development. It includes an increased emphasis on providing experiential opportunities for students, internships, and scholarships for high school and undergraduate students. NASA higher education efforts will increasingly target community colleges, which generally serve a high proportion of minority students, preparing them for study at a 4-year institution. NASA will use its unique missions, discoveries, and assets (e.g., people, facilities, education infrastructures) to inspire student achievement and educator teaching ability in STEM fields.

In fiscal year 2012, NASA will support the administration's STEM education teaching and learning improvement efforts, including the America Creating Opportunities to Meaningfully Promote Excellence in Technology, Education, and Science (America COMPETES) Reauthorization Act of 2010, Race to the Top and Educate to Innovate, while continuing efforts to incorporate NASA missions and content into

the STEM education initiatives of other Federal agencies. This may include providing competitions and challenges, supporting clearinghouses of Federal STEM education resources, providing high-quality professional development, and other engagements.

NASA will continue the Summer of Innovation (SoI) Pilot through partnerships with organizations that currently work with girls, minorities, and low-income students in grades 4–9 in summer and extended learning settings. The SoI project will deepen and broaden the efforts of communities and schools to successfully engage these students by providing high-quality, inquiry-based content, customized support, and access to NASA people, facilities and technology.

NASA will continue to partner with universities, professional education associations, industry, and other Federal agencies to provide K–12 teachers and university faculty with experiences that capitalize on the excitement of NASA discoveries to spark student interest and involvement in STEM disciplines. Examples of experiences include research and hands-on engineering in our unique facilities and on a variety of real-world platforms that include high-altitude balloons, sounding rockets, aircraft, and satellites. NASA will also partner with science centers, museums, planetariums, and community-based education providers to allow informal educators to engage students in NASA's real-time, cutting-edge science and engineering discoveries and challenges.

The fiscal year 2012 budget request places increased emphasis on cyber-learning opportunities and the use of the ISS National Laboratory to engage students (at all levels) in launch activities, research and engineering grants, and courses based upon NASA science and engineering.

In fiscal year 2012, the agency aims to increase the availability of opportunities to a diverse audience of educators and students, including women, minorities, and persons with disabilities. An example is the Innovations in Global Climate Change Education project that will be implemented within the Minority University Research and Education Program. The project provides opportunities for students and teachers to conduct research using NASA data sets to inspire achievement and improve teaching and learning in the area of global climate change.

CROSS-AGENCY SUPPORT

The fiscal year 2012 budget request includes $3,192 million for cross agency support, which provides critical mission support activities that are necessary to ensure the efficient and effective operation and administration of the agency. These important functions align and sustain institutional and program capabilities to support NASA missions by leveraging resources to meet mission needs, establishing agency-wide capabilities, and providing institutional checks and balances. Within this budget request, NASA has taken steps to reduce its administrative expenses, including a partial hiring freeze and reduced travel.

NASA's fiscal year 2012 budget request includes $2,402.9 million for Center management and operations, which funds the critical ongoing management, operations, and maintenance of nine NASA Centers and major component facilities. NASA Centers provide high-quality support and the technical engineering and scientific talent for the execution of programs and projects. Center management and operations provides the basic support required to meet internal and external legal and administration requirements; effectively manage human capital, information technology, and facility assets; responsibly execute financial management and all NASA acquisitions; ensure independent engineering and scientific technical oversight of NASA's programs and projects in support of mission success and safety considerations; and, provide a safe, secure, and sustainable workplace that meets local, State, and Federal requirements. Cross-agency support also funds salary and benefits for civil service employees at NASA Centers who are assigned to work on Center management and operations projects. In addition, the account contains center-wide civil service personnel costs, such as institutionally funded training.

NASA's fiscal year 2012 budget request includes $789.1 million for Agency Management and Operations, which funds the critical management and oversight of agency missions, programs and functions, and performance of NASA-wide activities, including five programs:

—Agency management;
—Safety and mission success;
—Agency Information Technology Services;
—Strategic capabilities assets program; and
—Agency management and operations civil service labor and expenses.

Agency management supports executive-based, agency-level functional and administrative management requirements, including, but not limited to:

—Health and medical;
—Environmental;
—Logistics;
—General counsel;
—Equal opportunity and diversity;
—Internal controls;
—Procurement;
—Human resources; and
—Security and program protection.

Agency management provides for the operational costs of Headquarters as an installation; institutional and management requirements for multiple agency functions; assessment and evaluation of NASA program and mission performance; strategic planning; and, independent technical assessments of agency programs.

Safety and mission success activities are required to continue improving the workforce, and strengthening our acquisition processes, including maintaining robust checks and balances, in order to improve the safety and likelihood of mission success for NASA's programs throughout their lifecycles. The engineering, safety and mission assurance, health and medical independent oversight, and technical authority components are essential to NASA's success. They were established or modified in direct response to several major Government accident and mission failure investigation findings in order to reduce the likelihood of loss of life and/or mission in our human and robotic programs. The budget request also supports operation of three activities that each provides a unique focus in support of the independent oversight and technical authority implementation:

—the Software Independent Verification and Validation (IV&V) program;
—the NASA Engineering and Safety Center (NESC); and
—the NASA Safety Center located at the Glenn Research Center.

Agency Information Technology Services (AITS) encompasses agency-level crosscutting services and initiatives in information technology (IT) innovation, business and management applications, and infrastructure necessary to enable the NASA mission. AITS includes management of NASA's scientific and technical information; identity, credential and access management services; overarching information security services; enterprise-level business systems; and, other agency operational services, such as email, directory services, and enterprise licenses. NASA's Security Operations Center (SOC) will continue to mature capabilities to improve security incident prevention, detection, response, and management. NASA will continue implementation of major agency-wide procurements to achieve:

—consolidation of IT networks leading to improved network monitoring, management, and reliability;
—consolidation of desktop/laptop computer services and mobile devices to achieve improved security and enable NASA Centers and programs to realize improved efficiencies;
—consolidation of agency public Web site/application management to improve the agency security posture and to facilitate access to NASA data and information by the public;
—minor enhancement and maintenance of integrated agency business systems to provide more efficient and effective agency operations; and
—reduction in overall agency data centers and related infrastructure currently funded outside the AITS budget.

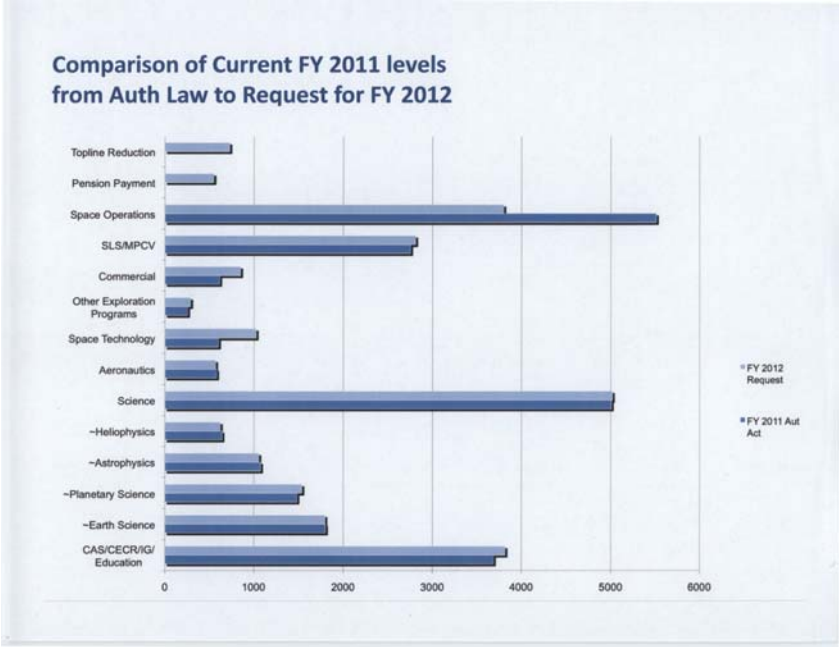
The Strategic Capabilities Assets Program (SCAP) funds key agency test capabilities and assets, such as an array of flight simulators, thermal vacuum chambers, and arc jets, to ensure mission success. SCAP ensures that assets and capabilities deemed vital to NASA's current and future success are sustained in order to serve agency and national needs. All assets and capabilities identified for sustainment either have validated mission requirements or have been identified as potentially required for future missions, either internally to NASA or by other Federal entities.

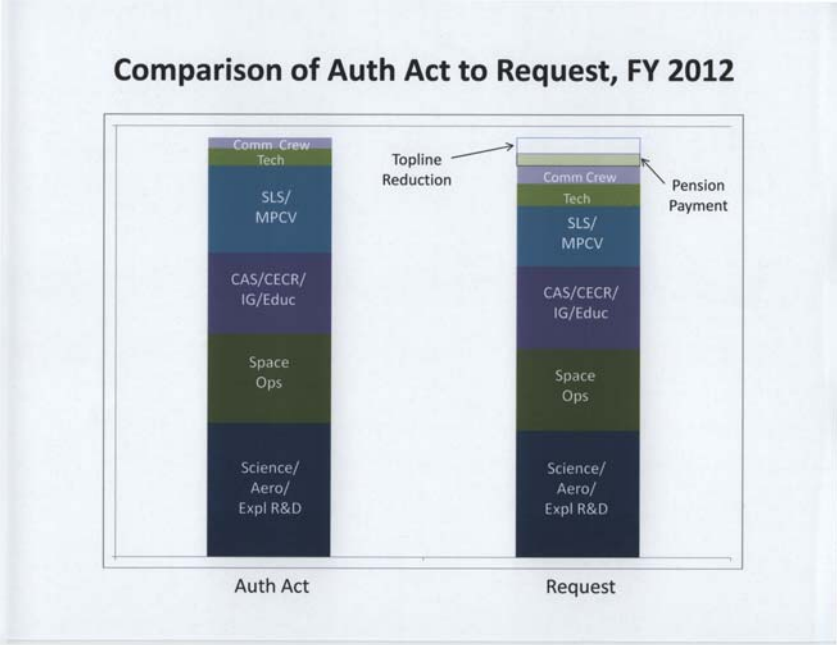
The Agency Management and Operations Civil Service Labor and Expenses funds salary and benefits for civil service employees at NASA headquarters, as well as other headquarters personnel costs, such as mandated training. It also contains labor funding for agency-wide personnel costs, such as agency training, and workforce located at multiple NASA Centers that provide the critical skills and capabilities required to execute mission support programs agency-wide.

CONSTRUCTION AND ENVIRONMENTAL COMPLIANCE AND RESTORATION

The fiscal year 2012 budget request includes $450.4 million for construction and environmental compliance and restoration. NASA construction and environmental compliance and restoration provides for the design and execution of all facilities con-

struction projects, including discrete and minor revitalization projects, demolition of closed facilities, and environmental compliance and restoration. The fiscal year 2012 budget request includes $397.9 million for the Construction of Facilities (CoF) program, which funds capital repairs and improvements to ensure that facilities critical to achieving NASA's space and aeronautics programs are safe, secure, sustainable, and operate efficiently. The agency continues to place emphasis on achieving a sustainable and energy-efficient infrastructure by replacing old, inefficient, deteriorated buildings and horizontal infrastructure with new, efficient, and high-performance buildings and infrastructure that will meet NASA's mission needs while reducing the agency's overall footprint and future operating costs. The CoF program prioritizes this budget based on risk of impact to NASA and Center missions, safety issues and accessibility. The fiscal year 2012 budget request includes $52.5 million for the Environmental Compliance and Restoration (ECR) program, which supports the ongoing cleanup of sites where NASA operations have contributed to environmental problems. The ECR program prioritizes these efforts to ensure that human health and the environment are protected. This program also supports strategic investments in sustainable environmental methods and practices aimed at reducing NASA's environmental footprint and lowering the risk of future cleanups.




Comparison of Auth Act to Request, FY 2012
Comm Crew
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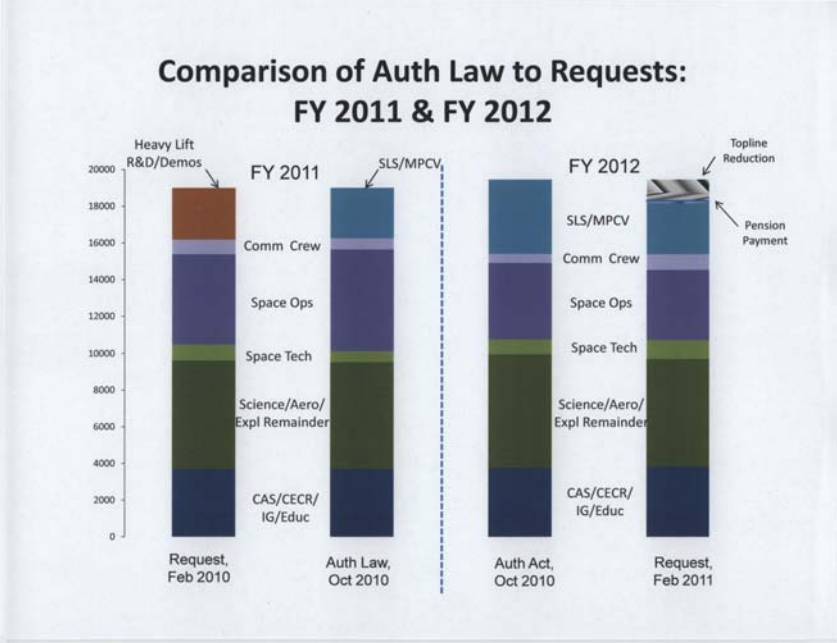
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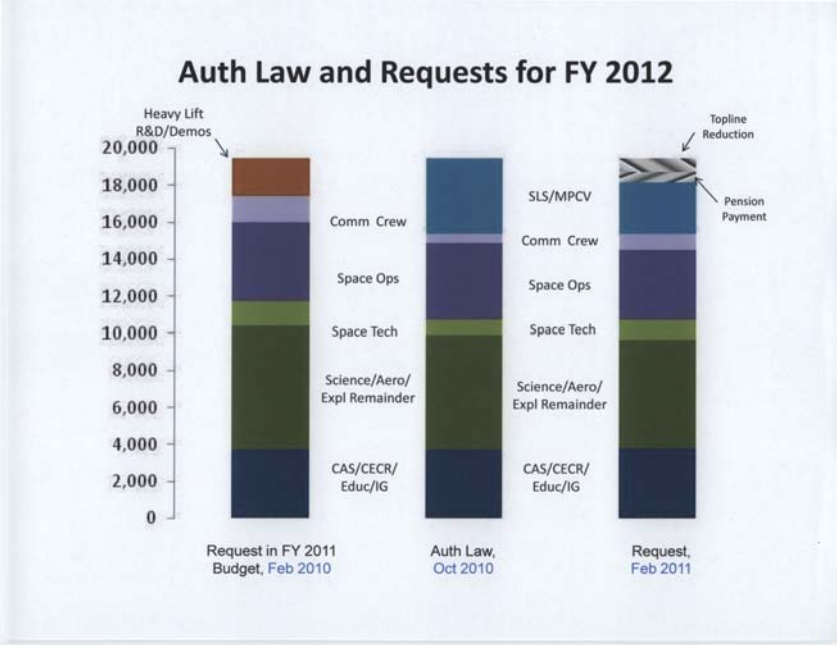
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Heavy Lift R&D/Demos
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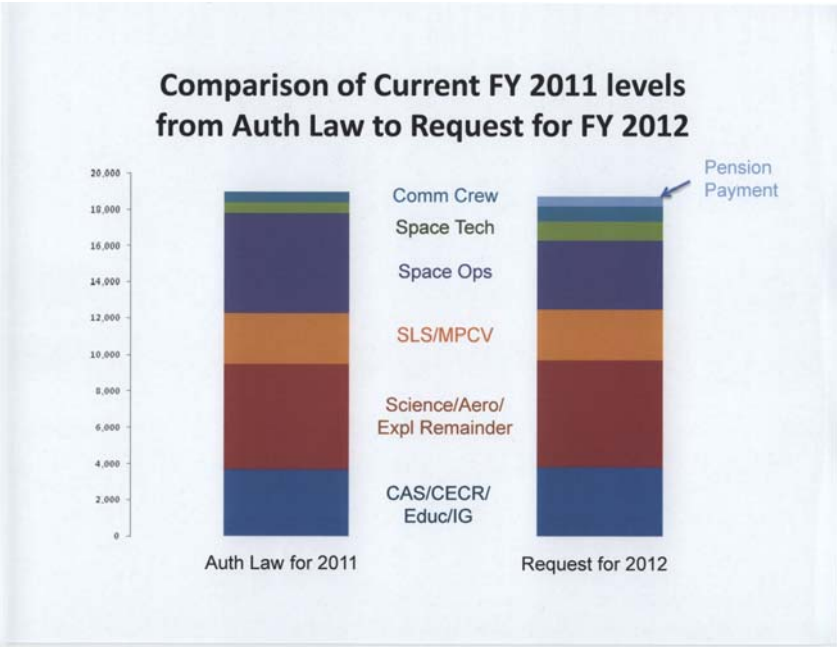
CAS/CECR/ Educ/IG
SLS/MPCV
Request in FY 2011 Budget, Feb 2010
Auth Law, Oct 2010
Request, Feb 2011


Comparison of Current FY 2011 levels from Auth Law to Request for FY 2012
Pension Payment
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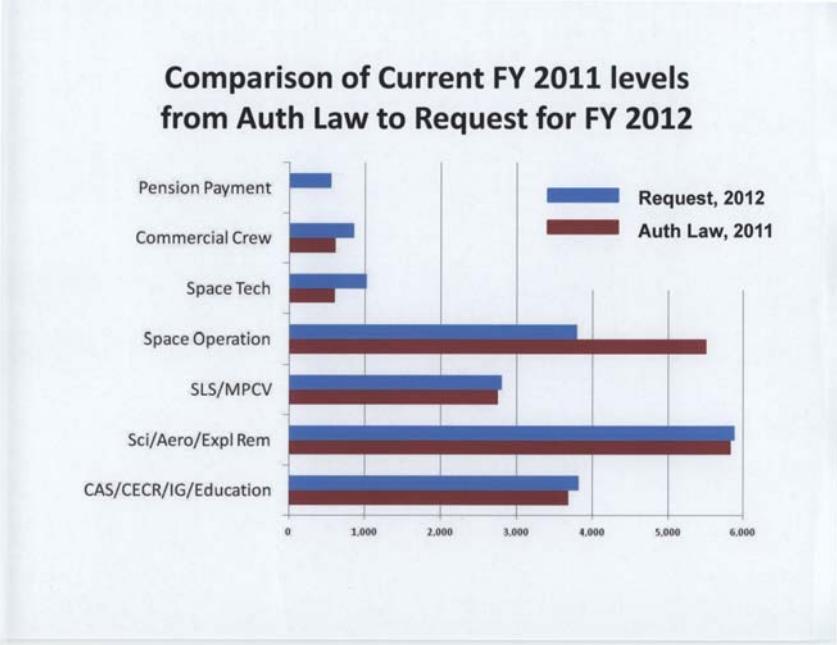
Space Tech
Space Ops
SLS/MPCV
Science/Aero/ Expl Remainder
CAS/CECR/ Educ/IG
Auth Law for 2011
Request for 2012


Comparison of Current FY 2011 levels
from Auth Law to Request for FY 2012
Pension Payment
Commercial Crew
Space Tech
Space Operation
SLS/MPCV
Sci/Aero/Expl Rem
CAS/CECR/IG/Education
Request, 2012
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0
1,000
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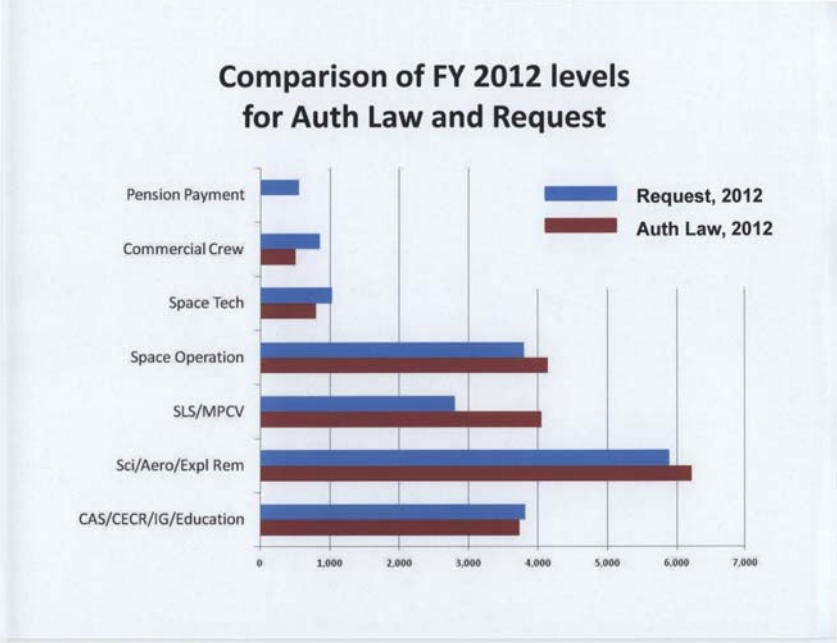
Comparison of FY 2012 levels
for Auth Law and Request
Pension Payment
Commercial Crew
Space Tech
Space Operation
SLS/MPCV
Sci/Aero/Expl Rem
CAS/CECR/IG/Education
Request, 2012
Auth Law, 2012
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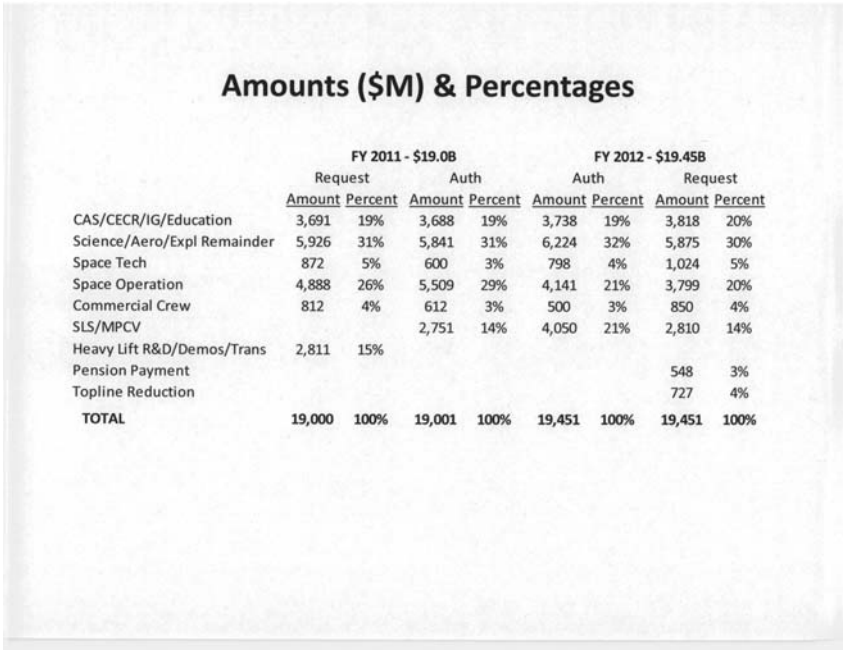

Amounts ($M) & Percentages

	FY 2011 - $19.0B				FY 2012 - $19.45B			
	Request		Auth		Auth		Request	
	Amount	Percent	Amount	Percent	Amount	Percent	Amount	Percent
CAS/CECR/IG/Education	3,691	19%	3,688	19%	3,738	19%	3,818	20%
Science/Aero/Expl Remainder	5,926	31%	5,841	31%	6,224	32%	5,875	30%
Space Tech	872	5%	600	3%	798	4%	1,024	5%
Space Operation	4,888	26%	5,509	29%	4,141	21%	3,799	20%
Commercial Crew	812	4%	612	3%	500	3%	850	4%
SLS/MPCV			2,751	14%	4,050	21%	2,810	14%
Heavy Lift R&D/Demos/Trans	2,811	15%						
Pension Payment							548	3%
Topline Reduction							727	4%
TOTAL	**19,000**	**100%**	**19,001**	**100%**	**19,451**	**100%**	**19,451**	**100%**

General BOLDEN. Thank you, ma'am.

Senator MIKULSKI. Now, we have, in other hearings, been talking about asking administrators about the consequences of the continuing resolution. Actually, where we are today, you're going to ask us the consequences of the continuing resolution. Rather than going into that today, here is what I suggest:

At midnight today, the Senate Appropriations Committee will present its bill. It, as I understand it, will be on the Web at www.appropriations.senate.gov.

Am I correct?

Senator COCHRAN. I'm not sure.

Senator MIKULSKI. Well——

Senator COCHRAN. I would defer to your judgment.

Senator MIKULSKI [continuing]. He's the ranking member of the full committee. So—but pretty much it will come out around midnight, that'll be the full bill.

My suggestion to you, and it would be enormously helpful, is that, when that comes out, I know you're going to scrub it——

General BOLDEN. Yes, ma'am.

Senator MIKULSKI [continuing]. To see what we did, so you know what you need to do. When you do that, it would be useful if you then could share with Senator Hutchison, Senator Inouye, Senator Cochran and I, what you think that means to NASA and what you think that means to 2012. We would be in speculative number games, and we're all rushing to meet those deadlines. And I know there's always a leadership blip here or there.

So, what we want to say, as full partners, scrub what we've done, then come back and tell us what it means to 2012, because, in effect, you're going to be below 2010.

General BOLDEN. Yes, ma'am.

Senator MIKULSKI. Okay?

General BOLDEN. Madam Chair, we'll do that and look forward to it.

JWST

Senator MIKULSKI. Now, let's go to the 2012, as proposed by the President and your advocacy today.

We want to join with the President in his national goal of outbuilding and out-innovating and out-educating. At the same time, we need to be stewards of the money.

I'd like to raise some questions about those things that could be targets for big cuts, particularly for those who have not spent the time on NASA, like our colleagues at the table. That goes to the JWST.

The JWST is scheduled to be 100 times more powerful than the Hubble telescope. But, we were troubled about its management. We were troubled about the use of money. We asked for a report, the Cassini report, which then said it was technically sound, but we had to worry how—we, meaning NASA, had to have a real sense of urgency related to management and keeping on track for both deadlines and expenditures. You and I have had a private conversation about that some weeks ago.

But, could you tell us now: What is NASA doing, number one, to have a sense of urgency; number two, that it has top-level attention—it hasn't been delegated to the coordinator of the coordinator of the coordinator; and that we have this spectacular opportunity on track now? Because, quite frankly, we—"we", on a bipartisan basis, cannot sustain technology with repeated cost overruns. The House won't put up with it. And, quite frankly, with no money to spare, we won't, either.

So, we want this telescope; it's important to our future. Tell us what you're going to do now to make sure we can deliver this; what your timeline is; and what your management and urgency activities are.

General BOLDEN. Senator, as you and I discussed when we did talk at Wallops and, as I told you then, I don't think there's anyone who was more disappointed and angry than I when we got to the bottom of the situation, where we found ourselves with Hubble. But, since then, we have moved with urgency. As I mentioned in my opening statement, the telescope continues to make exceptional technological progress. But, I have made some significant management changes in NASA. The program now is my responsibility, and I have delegated my associate administrator, Chris Scolese, to oversee that program for me. He meets with the team on a regular basis, several times a week, and also meets with some of your staff periodically.

Senator MIKULSKI. What is the team?

General BOLDEN. The team consists of Rick Howard, who is the program manager at NASA headquarters; and Ed Weiler, who is the Associate Administrator for Science. The program comes di-

rectly to him now. I extracted it from its former division, in astrophysics, because it was unfair to put a program of that magnitude in the astrophysics division.

Senator MIKULSKI. What are you doing about meeting with the private sector, building it?

General BOLDEN. We are working with Northrop Grumman, which is our prime contractor. We actually talk to Gary Ervin; I talk to Wes Bush periodically. They have made some management changes, and I would defer to them to explain to you what they've done. But, we communicate with them on a routine basis. As I said, Chris Scolese is usually talking to Gary Ervin every week. We're trying to make sure that——

Senator MIKULSKI. So, now, you've got this on track——

General BOLDEN. Yes, ma'am.

Senator MIKULSKI [continuing]. And you review it. Now, tell me, how much money is needed to keep JWST on track? And is it in 2012?

General BOLDEN. Senator, we are working to complete our bottoms-up assessment that will allow us to bring you a draft baseline assessment, hopefully by the end of this month. The final——

Senator MIKULSKI. Do you know——

General BOLDEN. Do I know——

Senator MIKULSKI [continuing]. This is——

General BOLDEN [continuing]. What it is——

Senator MIKULSKI. Yes, this is not argumentative or adversarial. I'm trying to drill deep on this issue.

General BOLDEN. We honestly do not think that we need money in fiscal year 2012 that will allow us to continue to carry the program to the point where we can make what we think now is a reasonable launch date of 2018. If something does happen, and we find that we have more funds than necessary in fiscal year 2012, we will put them to use to accelerate some of the testing that we're doing or some of the other developmental work. Right now, we are looking at how much we need to add to fiscal year 2012——

Senator MIKULSKI. Well——

General BOLDEN [continuing]. To come to this subcommittee and——

CASSINI REPORT

Senator MIKULSKI [continuing]. Going back to the Cassini report——

General BOLDEN. Yes, ma'am.

Senator MIKULSKI [continuing]. Which I know is advisory——

General BOLDEN. Yes.

Senator MIKULSKI [continuing]. They said they needed $500 million each year, in 2011 and 2012. And it's not there.

General BOLDEN. Senator, I respect the Cassini report. When we looked at what they said, and where we are in these fiscal times, I cannot responsibly bring myself to this subcommittee, or any other, and propose that someone try to find $500 million a year for the foreseeable future. We are working up a baseline, and there will be some additional spending that will be required, but we have not arrived at that yet. But, I hope to have you an original estimate by the end of this month.

Senator MIKULSKI. Well, my time is coming to a close, and I want my colleagues to be able to fully participate. I know of their keen interest, because, you know, we have big tickets in human spaceflight, and this telescope is a big ticket in space science.

First of all, we really appreciate the President adding $5 billion to the science budget.

But, let me tell you what I worry about: "Oh, we're going to live in our fiscal time and time of our austerity, and spartan." I'm all for that. Everyone at this table is for a more frugal Government. But, what I don't want to be is—I'm ready to be frugal, but I don't want to be foolish. So, let me tell you what I worry about in being foolish: that, because we skimp now, we then end up paying two or three times later. And that's what I don't want. I really need a realistic picture so that we could—this is a rational group of people who work together. We need to hear, truly, what is needed, not what you think you can get Office of Management and Budget to agree to——

General BOLDEN. Yes, ma'am.

Senator MIKULSKI [continuing]. Or what we can even get the House or ourselves to agree to. But, we need to know that. And what I also need to know is, if we don't spend the money now, when will we spend it, and will it ultimately cost us more? And I might be wrong, but I think we've been around the track on some of these things. Either the thing grows and becomes a boondoggle—you're now standing sentry, that won't happen. But, I'm again concerned that if we don't do the right thing now, it'll cost us more in the future. So, we really do need your wise counsel on this.

And we thank the President's support of science.

Senator Hutchison.

Senator HUTCHISON. I'm going to defer to Thad, and then I'll go after Sherrod.

Senator MIKULSKI. Senator Cochran.

TESTING CAPABILITY AT STENNIS SPACE CENTER

Senator COCHRAN. Madam Chairman, thank you very much for your leadership of our subcommittee and working in concert with our other subcommittee members.

Mr. Administrator, we appreciate your cooperation with our subcommittee, and your presentation today.

Despite some uncertainties about the fiscal year 2011 budget, I'm hopeful that we can stay on track to meet the goal of developing our heavy lift capacity for operation by 2016. And I'm hopeful that's at a 130-ton capacity. And I know that your advice is important in keeping us on track, in terms of taking the right steps with funding of those activities that will help us reach that goal. We want to be sure we have ample rocket testing results and an infrastructure to support this capability. We know that safety and competence and national interest are all goals that we share. And we know you are on that same team, and we appreciate your leadership.

You mention, in your written testimony, about the investment importance of a 21st century launch complex. And it strikes me, that's a way to describe what we have in the NASA facilities in the Mississippi/Louisiana area, which have become so important to this

launch infrastructure. Do you have enough funding requested in this budget request to ensure that we meet our updates to keep the schedules that are in place for fiscal year 2011 and 2012, to improve our rocket propulsion test infrastructure?

General BOLDEN. Senator, as you and I have discussed before, the 2012 budget that I put forth will support the continued development of our testing capability at Stennis Space Center. We intend to complete the construction of the A–3 Test Stand. As you are probably very well aware, Stennis has become rejuvenated and reinvigorated. We have had three tests now of the AJ26, just in this year, which is the rocket produced by Aerojet for Orbital Sciences Corporation. We have a test that's supposed to be going on today. When we get the A–3 Test Stand done, we'll be able to test even bigger and more advanced engines.

TESTING COMMERCIAL LAUNCH VEHICLES

Senator COCHRAN. What are your views toward using existing NASA infrastructure with regard to testing commercial launch vehicles?

General BOLDEN. We have demonstrated our capability to do that. In fact, the first time we tested an engine at Stennis in more than 10 years, it was the AJ26, Aerojet-produced. It's a Ukrainian rocket that Aerojet has modified for domestic production. It is also a rocket that we are currently talking to Aerojet about that has potential for upgrade, for even heavier lift than the Taurus II.

Senator COCHRAN. Do your future plans include subsidizing the construction of commercially owned propulsion test infrastructure elements?

General BOLDEN. I don't use the term "subsidizing". We provide the test facility, that's what Stennis is. It's the propulsion test center for the—we'd like to say it's for the world, but it's for the United States. We want to get everybody to come there and do their tests. We will make sure that we are competitive, in terms of cost, but we will take all comers.

Senator COCHRAN. Thank you.

Thank you, Madam Chairman.

Senator MIKULSKI. Senator Brown.

TEN HEALTHY CENTERS

Senator BROWN. Thank you, Madam Chair.

General Bolden, nice to see you, thank you.

The previous administration declared 10 healthy centers and laid out responsibilities for each. When you and I first talked, right prior to your confirmation, you assured me this policy was no longer needed, because NASA had 10 healthy centers. However, in last year's budget, NASA Glenn, in Cleveland, was promised the Exploration Technology Development Demonstration, the ETDD program. With the fiscal year 2012 budget request, we're giving $1 billion to the Office of the Chief Technologist, being told only that a significant—a substantial portion of the working leadership will be at Glenn.

Additionally, NASA has a history, as you know, of allowing its centers to fight among themselves. Not a day goes by that I don't hear that Cleveland's going—to that NASA Glenn's going to get a

mission, or somebody else—1 of the other 9 is trying to take a mission from NASA Glenn and from each other. Now, I hear some NASA leadership saying that, instead of collaboration between and among centers, they want to encourage, again, that competition. While I have great respect for Dr. Braun, I've seen what happens when the Congress provides NASA latitude to shift funds.

I have two questions on this issue. One, do you have a serious commitment to the goals of the previous policy of 10 healthy centers and the people that work there? Two, how will you work with the Congress to detail a more specific plan for 10 healthy centers?

General BOLDEN. Senator, I have a very serious commitment to 9 functioning, effective, efficient NASA centers and one laboratory, the Jet Propulsion Laboratory. You know, "healthy" is a relative term. Because of the fiscal constraints that we are all under now, our centers are stressed. You talk about H.R. 1, for example; change like that would have a dramatic effect on a center. But, I have the best center directors in the world. I have the best workforce in the world, and we're doing everything we can to make sure that we balance the work across the 10 NASA centers. We want to make sure that we have a balanced portfolio in the agency. We want to have vibrant involvement in aeronautics, in technology development, in science, and in human spaceflight.

I'm not asking every center to be capable of participating in every single thing we do. I want to find out what their sweet spot is and then let them go do that. I think the center directors enjoy that, the members of the workforce enjoy that. But, I am committed to making sure that all of our centers stay as strong as they can.

ETDD

Senator BROWN. And I can be assured that ETDD's work will be at Glenn, regardless of where the OCT is located.

General BOLDEN. The answer is "Yes".

Senator BROWN. The people at Glenn don't necessarily believe that——

General BOLDEN. Well, the——

Senator BROWN [continuing]. You understand.

General BOLDEN [continuing]. Point that I tried to explain and I think I know the center director does. And it's because——

Senator BROWN. He does.

General BOLDEN [continuing]. He understands and, as Ray Lugo has probably told you before, he's not worried about having titles at his center; he is interested in having the contracts and the work. So a program management office at a center does not mean that the center is going to handle the bulk of the work in that program. It just means that 's where the focus of the oversight is going to be. But, work on ETDD—Glenn is where much of it is being done and will be done. So, Glenn will make out relatively well.

DISPOSITION OF ORBITER VEHICLES

Senator BROWN. Let me shift to an issue that we've talked about many times. I'd like you to detail the selection of the shuttle that—the process NASA undertook in deciding where the retiring shuttles would be exhibited. I never heard you or your top assistant or

the White House or anyone else talk about this commission, that supposedly was put together 4 years ago, that will apparently decide the disposition policy with the NASA authorization law that set out guidelines in the role that the commission is playing. Could you explain, one, who is the one that's ultimately going to decide——

General BOLDEN. Is this a commission on deciding where the orbiters go?

Senator BROWN. That's my understanding.

General BOLDEN. If there is such a thing, I don't know about it. I am going to make the decision, probably when I get back over to my office this afternoon, so if I need to consult with them, somebody should tell me, really quick.

Senator BROWN. Will you just make that decision based on the last person you talk to, by chance?

General BOLDEN. No, Sir, my team has put together——

Senator BROWN. A "Yes, Sir" would have been much more preferable.

Senator MIKULSKI. You know, you could end up with a filibuster on this subcommittee, if you——

Senator HUTCHISON. And I have to follow you, Senator Brown.

General BOLDEN. My team and I—that's a good point——

Senator MIKULSKI. For once, I have no dog, or orbiter, in this fight.

General BOLDEN. There are—well——

Senator BROWN. So, the decision is totally yours, there is no statutory commission to which——

General BOLDEN. Not to my knowledge.

Senator BROWN [continuing]. The matrices that you must—on which you have to base your decision.

General BOLDEN. I have made an effort to keep people, not the President, but people close to the President, informed of the process that we were following. I have made an attempt to keep at least the staffs, here, in both the House and Senate, informed of the process that we were following. We offered to brief people on the process. We established, I think, 10 criteria for consideration.

We had 29 applicants for an orbiter. All of them met the criteria, in varying degrees. So, I will make my decision this afternoon based on points that were assigned to the degree to which they met those criteria. It has nothing to do with where it is, or anything. It's just how they fell out in a matrix of criteria, and the points awarded for that. There will be 25 people who won't be happy; 4 who will be really happy.

Senator BROWN. The three shuttles that will be sent to these three locations, is— are you also deciding on the *Enterprise*, the one that has never, and will not have, flown? Or are you only making that decision on the three that have flown or will have flown?

General BOLDEN. The decision is being made on the distribution of all four orbiters, because the Smithsonian is in competition with everyone else. So, I have four orbiters to dispose of. All of them have, I know I'm being picky here, but all of them have flown. *Enterprise* was the first orbiter. It conducted all of the approach and landing tests. It flew three times—I mean, had some pretty challenging things happen to it, also. So, it is quite a vehicle, in and

of itself, in terms of being a pioneer vehicle. But, those four vehicles will be distributed around the country to the four places selected.

Senator BROWN. But, the *Enterprise* been promised or owned in some by some definition, by the Smithsonian?

General BOLDEN. By law, the Smithsonian is the recipient of all artifacts that come from spaceflight. So, we are working with the Smithsonian and my committee to determine just how we go about that. But, I will——

Senator BROWN. So, if one of the——

General BOLDEN [continuing]. I will make that announcement tomorrow——

Senator BROWN. Okay.

General BOLDEN [continuing]. At 1 o'clock——

Senator BROWN. If one of those three——

Pardon me, can I continue for 2 more minutes, Madam Chair?

This matters a lot to Dayton, Ohio. And I know—and she's going to—I understand. I understand. I won't take much——

If those three—if one of those three that has been defined as having a mission and going up and—while the *Enterprise* is defined a little less so, generally—if one of those three goes to Washington, goes in the Smithsonian, does that mean that this the *Enterprise* will go somewhere else—I assume.

General BOLDEN. If one of them ends up at the Smithsonian—they only get one. So, that means that I will take possession of *Enterprise*, and then it will be up to NASA to determine where *Enterprise* goes.

Senator BROWN. In that decision, if one of these three goes to—one of the first three, or "the" three, goes to the Smithsonian when you make your decision tomorrow, you will then—right then, decide where the, some call it the consolation prize, others call it much more than that—you will make that decision then——

General BOLDEN. I'll make the——

Senator BROWN [continuing]. Where the fourth one goes.

General BOLDEN [continuing]. Determination between when I leave this session and when I announce it tomorrow, where all four——

Senator BROWN. Okay. And——

General BOLDEN [continuing]. Space shuttle orbiters are going. So, when we make the announcement tomorrow, it will be very specific. It will cite the orbiter and its destination.

Senator BROWN. Okay.

Thank you. Thank you, General.

General BOLDEN. This process has been as pure as I could make it, and free of any political involvement. I can say that until I'm blue in the face, but there will always be someone who will have the opinion that was not the case. But, the team that was put together before I became the Administrator has done an absolutely incredible job over the last couple of years. I would just hate to see their work be castigated by somebody who assumes that they were unduly influenced. They were not.

Senator BROWN. And, General, you of course know that Dayton, Ohio, is within a—1 day's drive of 60 percent of America's population——

General BOLDEN. I do, indeed.

Senator BROWN [continuing]. And that the Wright brothers and Neil Armstrong and——

Senator MIKULSKI. And John Glenn.

Senator BROWN [continuing]. And John Glenn all called Ohio home.

General BOLDEN. I know that all very well, from lots of phone calls from——

Senator MIKULSKI. The only two prominent people I don't know from Ohio are Mother Theresa and Nelson Mandela.

Senator BROWN. No, they actually are. Thanks, Madam Chair.

Senator MIKULSKI. Senator Hutchison.

CONSTELLATION PROGRAM CONTRACT MODIFICATION

Senator HUTCHISON. The NASA authorization bill allows NASA to modify any contract from the Constellation program. And, of course, it seems that Orion would be the perfect candidate for such action, because the whole theme of the authorization bill is to use the technology, expertise, and experience that we've already invested in to go to the next generation of vehicle. The President himself brought back Orion last year. He wanted Orion continued. And your staff and managers agree that Orion is the reference vehicle, and easily falls within the scope of the authorization law that you have said you are following.

Yet, it doesn't seem that the contract modifications to achieve this result are happening. Do you intend to modify the current launch vehicle and Orion contracts, as directed in the authorization law, or is it just going to be strung out so that eventually it just can't be revived?

General BOLDEN. Senator, there may be no requirement for a modification on the contract to Orion. The present Orion was designed as a deep-space exploration vehicle. If it's found that—the basic information that we have at hand today says that the scope of the existing Orion contract as a deep space exploration vehicle easily maps to the scope of what we call a MPCV. It may come to the fact that it matches so well that there's no need to modify the contract.

I will tell you that, in any of the contracts that we have today, we cannot pay the amount of money that was contracted *X* number of years ago. So, there will be negotiations among us and all of our contractors, because we have got to get our costs down. We may have to de-scope the vehicle in some manner. Orion is the design reference vehicle for MPCVs. So, what it's called——

Senator HUTCHISON. Let me just ask you this—are you taking the previous contracts, the Constellation, which is no longer, and modifying those so that we get the next generation, the Orion, both launch and capsule——

General BOLDEN. Senator, that's our hope. We have had the lawyers, the procurement folks, everybody, look at mapping the scope of the existing contracts to what it is we want to do for an evolvable heavy lift launch vehicle and MPCV. I'll go back, because Senator Cochran mentioned a 130 metric ton vehicle—that is the ultimate——

Senator HUTCHISON. Okay.

General BOLDEN. That is where we will end up. We will end up with, no question, a 130 metric ton vehicle, because that's what we judge is needed if we're going to do a deep space exploration to asteroids and Mars and other places.

Senator HUTCHISON. Do you——

General BOLDEN It will be an evolving program to get there, though. The first vehicle that we fly may be a 70 metric ton vehicle. But, we will eventually have 130 metric ton vehicle.

UTILIZATION OF THE CONSTELLATION CONTRACTS

Senator HUTCHISON. The budget request, at the $2.8 billion level, which is level until 2016—are you telling us that you are using the previous experience and expertise from Constellation and transferring that in an expeditious and timely manner so that it is going to be done in a timely way, even with the flat line budget that you are requesting?

General BOLDEN. Senator, we are using the experience, expertise, and assets of the Constellation program to the greatest extent possible. The vehicle Orion is already in testing as an MPCV. Lockheed Martin, under its Constellation contract, which I am not allowed to terminate at my direction, the Constellation program, which does still exist—I told them that we should focus on putting our money on technology and assets that could move forward to a deep space exploration system. And that's what we're doing.

So, we are not making much progress on a heavy lift vehicle right now, because it is not clear that the Ares configuration is what you want to go with. As you saw, the design reference vehicle, for a space launch system (SLS), is a shuttle-derived system, not the Ares system. So, I know that there will be some contract mods required to go from an Ares type system to a shuttle derived system, which is the design referenced——

Senator HUTCHISON. You say that you're not able to——

General BOLDEN. Design referenced vehicle for now.

Senator HUTCHISON [continuing]. Cancel Orion, but the authorization bill vitiated the—or took the place of any previous supplemental or appropriations bills. So, the law is the authorization bill. Are you saying that you believe that you are fully utilizing the previous Constellation contracts for the next generation of vehicle, that we are not wasting money pursuing something that is now obsolete, but that you are expeditiously using that money for——

General BOLDEN. Senator——

Senator HUTCHISON [continuing]. The Orion vehicle——

General BOLDEN. Senator, we are complying with the requirements of the authorization act. But, I'm out of my league, here, so I will ask your staff and some of my folks to—I will say, my understanding is, I am still governed by the 2010 appropriations——

Senator MIKULSKI. Yes.

General BOLDEN [continuing]. Law, and that is what says I cannot cancel. I can take no action to cancel the Constellation program or to stop any expenditures on that program. What I did, though, was, I said, I want to make sure that we spend the taxpayers' money very prudently. So, in some cases, we stopped doing things that were in the Constellation program, because we knew they weren't going anywhere, things that had not begun yet. Contracts

that we hadn't even started, I said, "Okay, let's not start them. We have not funded them, we have not started them, let's just stop right there." But——

Senator MIKULSKI. Let me just cut in here.

General BOLDEN. Yes, ma'am.

Senator MIKULSKI. Senator Hutchison, Administrator Bolden is right, they are still under the excellent authorization you and Senator Nelson did, did not remove the prohibition regarding Constellation.

General BOLDEN. Yes, ma'am.

Senator MIKULSKI. However, I think if we all just sit tight, look at what we're going to be looking at as the continuing resolution moves forward now, I think that you're going to see there's some flexibility. So, if everyone could—your questions are excellent.

Senator HUTCHISON. Well, I mean, it's, they can modify and use common sense to know that the authorization bill takes the place of the original 2010 supplemental——

General BOLDEN. And, Senator, you know——

Senator HUTCHISON [continuing]. And you are going to get more help—hopefully within this week.

General BOLDEN. Senator, we've—again, I think the——

Senator HUTCHISON. But, I just, our concern is that you have not been using the capability that you have for modification to stop obsolete things, but continue using the same technology, experience, and people, moving forward toward Orion.

General BOLDEN. Senator, I have directed that we spend money on things that will be useful for the exploration system going forward. You had an inspector general report that said that we were wasting funds by spending money on obsolete Constellation contracts, and that is not the case. We took issue with that report, and we submitted our own report to you, to identify the areas where we were doing exactly what you said.

We are spending money, for example, on the Orion vehicle, because it maps well to the MPCV. We are spending money on doing some things from the Orion program—from the Constellation program—that look like they will map well to an SLS. But, we are trying not to spend money on things that will not go forward. So, we're not wasting the taxpayers' money.

Senator HUTCHISON. Well, that would be our hope. And know you know we have worked with your staff and with the Government Accountability Office (GAO) to completely clarify, going forward after this next continuing resolution, that you will have complete freedom to completely follow the Orion pursuit and the 2010 law that was passed for authorization.

Madam Chairman, I do have another question, but——

Senator MIKULSKI. Sure.

Senator HUTCHISON [continuing]. I know other people are——

Senator MIKULSKI. No, go ahead.

Senator HUTCHISON. If you have a second round, if you want to go again——

Senator MIKULSKI. Why don't you ask that question, and then we'll pick up——

Senator HUTCHISON. Okay.

Senator MIKULSKI [continuing]. If any members want a second round.

DISPOSITION OF ORBITER VEHICLES

Senator HUTCHISON. I just want to go back to the law that was passed in 2010 regarding the disposition of the orbiter vehicles. And since Senator Brown suggested that maybe the last person you talk to might be the one that you listen to—I'm kidding, but, here's what it says: that the criteria should have priority consideration given to eligible applicants that meet all the other conditions, providing for the display and maintenance at locations with the best potential value to the public, including where the location of the orbiters can advance educational opportunities in science, technology, engineering, mathematics disciplines, and with a historical relationship with either the launch, flight operations, or processing of the space shuttle orbiters or the retrieval of NASA manned space vehicles, or significant contributions to human spaceflight.

So, you know, that seems—I mean, if you go back to that priority consideration, it just seems to me that it would be very difficult to leave out both Houston and Florida. Now, I know you're getting ready to make the decision, but I think you have acknowledged that in the past, as well; I mean, when people think of our space shuttles, they think of Mission Control in Houston and the astronauts training in Houston, and they think of the cape where we launch.

So, I just want to ask you—in your determinations, you're weighting these factors—how much is the historical relationship with, as the law says, flight operations, launch, et cetera, weighing in the factors that you're putting in your decision?

General BOLDEN. Well, the 10 criteria that were used by the people that made the recommendations to me did not include the prioritization from the law. I was aware of it. And so, I think you will find when the announcement is made, that every place receiving an orbiter has a historical connection to human spaceflight. In fact, I think you will find that every one of them has a historical connection to the space shuttle.

Senator HUTCHISON. So, the other——

General BOLDEN. And that does not——

Senator HUTCHISON [continuing]. Did not put that in——

General BOLDEN. I'm not——

Senator HUTCHISON [continuing]. But the priority of the law would prevail, correct?

General BOLDEN. Yes, ma'am. We will comply fully with the law.

Senator HUTCHISON. Thank you.

Thank you, Madam Chairman.

CONTINUING RESOLUTION

Senator MIKULSKI. Mr. Administrator, I want to come back to Senator Hutchison's questions about Orion, Constellation, et cetera. Here is—my suggestion is—sometime this week, we're going to pass the final continuing resolution for this year, and you'll be scrubbing what we've done, as I said, you know, on appropriations.senate.gov, et cetera. What I am going to suggest is that your staff review the legislation and the issues raised by Senator

Hutchison, come back and brief the Senator's staff, and my own, just exactly where we are on this topic—and, of course, the Inouye and Cochran staff will always be present, at their pleasure. But, we want to make sure we all understand the same thing, and then identify if there's any further clarification language we need to do or anything else to look at this.

Does this sound like good way to go?

Senator HUTCHISON. I think——

Senator MIKULSKI. Because I think there's confusion, right this minute, between the authorization which you are mandated to do and what might be some activities we do in continuing resolution.

Senator HUTCHISON. I think, as much input as we can get and as much as we can work together, absolutely. I just believe, so much, that our goal was a balanced approach for manned spaceflight, and that we would have the commercial and the NASA experience working hand-in-hand, on a dual track, for the development of the next generation of vehicle. And that's what I'm trying to achieve. And I hope that it's what you're trying to achieve, because that's what we're trying to do in this continuing resolution and in the 2012 follow on budget. So——

Senator MIKULSKI. Well, what I'm trying to approve is the policy goals——

Senator HUTCHISON [continuing]. Any input is helpful.

General BOLDEN. Yes, ma'am.

Senator MIKULSKI [continuing]. That we have agreed upon through the authorization, with wise stewardship of Federal funds, which I think we're all committed to. And we are in an atmosphere of making every dollar count.

General BOLDEN. Yes, ma'am.

Senator MIKULSKI. So, we want every and all talent to count. I was so pleased, in your comments and in your opening statement, that you acknowledged the incredible talent that's at NASA. And I think we all share it. And a lot of people put a lot of hard work into that, so we don't want to throw out the ideas and what we can benefit from it. We don't want to waste any money through what was a good idea through a mandate once, but might no longer be a good idea.

And then we're all obsessed with jobs, Mr. Administrator. And, as the shuttle winds down, people, as you know, are deeply concerned in Florida, people at all the centers are very worried about jobs. And I think what we're looking at is, how do we continue innovation jobs in the future? But, I think every member here is concerned about jobs today. So, we need to talk about that.

NASA CONTRACT MANAGEMENT

But, I want to come back to a frugal Government and making dollars count. I know GAO has identified NASA contract management as they've got NASA on the high-risk list. In its annual review of large-scale NASA projects, GAO found that development costs for the 16 projects that have entered major development had grown nearly 15 percent. And that's not even with the JWST issue. Now, GAO has also told the subcommittee they're encouraged by NASA's corrective action plan to address flaws in acquisition management.

So, here is my question. You're on the high-risk list; GAO says you're making progress. Our question to you is, what are you doing to make sure that NASA contract management is back on track implementing the GAO recommendations? And also, the last part of this question is, should we be moving away from cost-plus contracting to fixed-price contracting, or is that just a cool gimmick? So, that's a lot. How do you get off the GAO high-risk list? What are you doing so that we feel confident about this? And then, if you've got thoughts, now, actually, on a new world order in contracting?

General BOLDEN. Senator, I guess the first thing I would say is, in hoping to manage expectations, I doubt that NASA will ever be off the high-risk list from GAO, because everything we do is high risk. We do dangerous stuff, we do risky things and we take big challenges that nobody else can do. So, unfortunately, we do one of a kind type programs. So, we do things that have never been done before.

However, being on the high-risk list, I can still make my program management better. We've established key decision points in every program that we do now. So, those are milestones that the program and project management have to take an assessment of: How are we meeting our cost and schedule goals? We look at life-cycle targets. We establish, at the outset of a program, how much we think it's going to cost to not just design a system, or design and build, but how much is it going to cost to operate that system?

So, when we bring you an estimate for a system today, it's a life-cycle cost estimate, as we're trying to do with JWST and others. We instituted something called the Joint Confidence Levels (JCL), where we look at cost and schedule. And unfortunately, this came about in 2009, and it was right after JWST had been baselined. But, we have two examples, in Gravity Recovery and Interior Laboratory and Juno; both of them will fly by the end of this calendar year, and they are on target in every respect, because they went through the JCL process, the total life-cycle process. We're very confident that, when we say we're going to deliver, we're going to deliver. We use independent assessments that are based on earned value, and that's what we're doing now.

We have retrained our program and project managers. We put them through a rigorous training course that they have to finish. One of the things it talks about is discipline, so if they're managing a science project, they learn how to say no when somebody says it would be a good idea to add one more experiment or a good idea to add one more instrument. So, we're going to de-scope a lot of missions that we have right now that just don't meet the smell test in this fiscally constraining time.

COST-PLUS CONTRACTS—FIXED-PRICE CONTRACTS

Senator MIKULSKI. Well, first of all, that's very encouraging. And we know you took the GAO flashing yellow lights very seriously.

But, what did you think about my question about moving away from cost-plus contracts to fixed-price contracts?

General BOLDEN. We would—in every——

Senator MIKULSKI. And I'm not saying I advocate that.

General BOLDEN. No, no, no, no I understand, ma'am.

Senator MIKULSKI. I'm really soliciting your views.

General BOLDEN. To the greatest extent possible, for the benefit of the Government, we would always prefer to have a fixed-price contract, where the Government signs a contract up front and follows its commitment to pay the contractor as they meet milestones. Because we do one-of-a-kind things, sometimes, when we're in a development program, or in the development phase of a program, a fixed-price contract might not be the most prudent thing to do. We may need a cost-plus contract until we get through the unknown, the uncertain part of the development cycle.

Once we do that, you will go through multiple types of contracts over the life of a program while it's being developed, where you move from a cost-plus contract during the development phase to a fixed-price contract when you go into the final phases of production.

CONTRACTING AND ACQUISITION

Senator MIKULSKI. Well, and it's not—today, we're not going to go into this, but we're really looking at contracting and acquisition——

General BOLDEN. Yes, ma'am.

Senator MIKULSKI [continuing]. In every one of the agencies, in our subcommittee. Not because we're going to break new ground; it must come through authorization and working with the executive branch. But, contracting, as we know it, I think, is going to be reviewed.

You know, we make these—we sign up for a contract—what you said—"one of a kind, we do what nobody else does." But, the fact isit often takes 5 to 7 years to develop it; our mission changes or gets altered, politics change, and technology changes. And there we are, stuck with—not stuck, but in a track for a particular way and a particular cost and so on, and I'm not sure what's the best way to go.

I do believe there are lessons learned that are going on in Defense, through Secretary Gates and Dr. Carter and his initiatives. They're not all applicable, but I think we need to be able to look at it.

But, that's not for today. Today, we need to get that continuing resolution out on the Web, get it on both of our floors. Let's close out this year's 2011 appropriations and get a good direction on 2012.

General BOLDEN. Yes, ma'am.

Senator MIKULSKI. Senator Cochran, did you have any other questions, Sir?

Senator COCHRAN. I do not. Thank you, Madam Chair.

Senator MIKULSKI. Senator Hutchison, do you have any other? And then I'll——

Senator HUTCHISON. I have four questions that I'd like to submit for the record and ask that you respond to. They're not—I don't need to ask them here, but they are just general questions that I'd like to ask you——

General BOLDEN. Yes, ma'am.

Senator HUTCHISON [continuing]. To respond to, that I'll give to the Chairman.

Senator MIKULSKI. Senator Brown?

HUMAN-RATING REQUIREMENTS

Senator BROWN. Yes, thank you, Madam Chair. I have another couple of questions. Mr. Administrator, a study some time ago of 454 U.S. satellites found that fewer than 10 percent of spacecraft that complied with the military standard 1540B Qualification Test Program suffered failures, while more than 60 percent, almost two thirds, failed when only one-half of the qualification tests were performed. Since then, in 2009, a NASA satellite was lost, as you know. And, just a month ago, another NASA satellite was lost.

In the wake of the loss of these two, due to launch vehicle failures and the intent to utilize commercial crew in cargo launches for the ISS, my thoughts are of concern. First is for the safety of our astronauts and for the successful launch of supplies and critical hardware to orbit. What type of full-scale environmental testing is NASA requiring now or going to require of the commercial companies to achieve certification for human spaceflight? And what sort of full-scale environmental testing are we planning to qualify our own MPCV and SLS vehicle? What are you planning?

General BOLDEN. Senator, we are in the process of developing what we call human-rating standards. We actually have a series of 1,000 level NASA requirement documents that will deal with what stipulations a contractor has to meet in order to qualify to carry either our cargo or our crew members. As you said, my number one objective is the safety of our crews. So, we will not certify an industrial partner to carry a crew unless we're satisfied that they have met all of our safety requirements.

If I look at Orion, almost all vehicles go through thermal vacuum testing, they go through vibration testing, they go through radiation testing to make sure they're radiation-hardened and the like. So, any test that would have been required of, or will be required of, my MPCV, a commercial vendor will have to pass the same test or demonstrate that they have passed a like test, before we will put an astronaut on them, because we've got to be sure that they're safe.

PLUMBROOK TESTING FACILITY

Senator BROWN. What role do you envision Plum Brook playing in those testing of commercial and our vehicles?

General BOLDEN. What would—I'm sorry?

Senator BROWN. What role do you envision Plum Brook playing in that?

General BOLDEN. Well, it depends on the vehicle, itself, or the capability of the developer, the capability of the industry partner, to find another facility. I think you know, what Ray Lugo is doing as the center director at Glenn, is going out to industry and advertising the capabilities that we have at Plum Brook, just as Patrick Sherman is doing at Stennis. We are actively going out to industry and saying, "Hey, we have the best facilities in the world. Please use our facilities." I envision that we may have some of those contractors wanting to bring their crew vehicles through Plum Brook for testing. It is the best facility that NASA has. I'm certain it's better than anything else they can come up with.

The big thing we're trying to do is help them with their costs. Every facility that they don't have to build means more money to their shareholders. We promise that we will give them a reasonable price, but we do have to get back full value for the taxpayer. We don't have any sales.

GLENN RESEARCH CENTER

Senator BROWN. Right. Well let me ask one more question, Madam Chair.

NASA Glenn has been leading the work for the Orion service module for Ares I upper stage electrical avionics and thrust vector control systems in the Ares V payload fairing. The work performed on these vehicles directly translates to the MPCV, to the MPCV, and the SLS as you know. In what specific way do you plan on utilizing NASA Glenn's heritage and proven expertise in these new MPCV programs and in SLS programs?

General BOLDEN. I will have Ray Lugo get in touch with you, but I would venture to say, any work that Glenn was doing with Orion will be the same work that Glenn continues to do with the MPCV, whatever we call it. You know, they are small propulsion. They do ion engines, electric engines, and the like. So, those types of things that they were responsible for in the Constellation program, they will continue to be responsible for in any program that we do, going forward.

If I go back to something that the chair mentioned: it is my hope that, within the week, we will be able to bring to the staff a report that I have received, that my senior management has been receiving incrementally now, on the MPCV—the plan for the plan, if you will—on the MPCV, the SLS, and 21st century launch complex. We have done incredible work. We have not been standing still. We've been doing this for almost a year now, and this is what supported our making the decision on the design reference vehicles. But, we're now ready to bring that to the committees so that you can get incremental looks at how we're progressing, so that you see that we are not stalling, we are not standing by, we're not wasting time nor money, that we have a plan, and that, if we are able to follow that plan, and that plan is sufficiently supported by budgets that we say we need, we will develop the best heavy lift launch system they have ever had and a deep space exploration vehicle that will do the things that we've all dreamed about up until now, but nobody's had the courage to do. So, we are going to do that. It's our desire to bring those reports to this subcommittee, to the staffs, at increments as we go along.

Senator BROWN. Thank you, Mr. Chairman.

Thank you.

STS–134 SHUTTLE FLIGHT MISSION

Senator MIKULSKI. Mr. Administrator, we know, in 2 weeks, there is going to be a historic flight. And one of our last shuttles will go into space. We know that Captain Mark Kelly will be leading that effort. And we hope, with God's good grace and American medical care, that Congresswoman Giffords can see this. I think the entire subcommittee, and really the entire Senate, really wish-

es them, through you, Godspeed. And we really hope that NASA continues to do what it does best. So, good luck to them. And——

General BOLDEN. Thank you.

Senator MIKULSKI [continuing]. May the force be with them.

General BOLDEN. We really appreciate it.

Senator HUTCHISON. Madam Chairman, could I add to that and say: I, too, am so looking forward to this, because it has a very poignant side to it, because of Captain Kelly and his wife, who we all are pulling so hard for to be able to come.

But, also the spectrometer going up is such a big deal. This is the last major big piece of equipment that will be going, that has such enormous potential for the look at dark matter energy. And it was before one of the previous NASA Administrators, who said Dr. Ting, from MIT—who insisted that this was the one thing that we could do in microgravity that would be so important in the energy field. And Dr. Ting is a Nobel laureate, and we listened to him, and now his dream is becoming reality in this launch. So, it has so many important——

General BOLDEN. Yes, ma'am.

Senator HUTCHISON [continuing]. Historic and significant aspects to it. And I'm very excited about it as well, and looking forward to having that piece put in. And then our last launch on need mission, that is now going to be in June, we're very excited about doing the very last payload lifting that we're going to need to do until—we don't have an American capability, but we all want to——

Senator MIKULSKI. No. But, we will.

General BOLDEN. We'll get it to you soon.

Senator, may I make one comment? Because I—just to help people put things into perspective.

STS–134 is an incredibly critical mission. It's high profile. It's everything. I wear a bracelet for Gabby, because she's a personal friend. My number one objective, my number one goal, is making sure that our astronauts are safe. So, with all the high profile and everything, I want to keep all the pressure away from Captain Mark Kelly.

Senator MIKULSKI. Right.

General BOLDEN. Captain Mark Kelly is one incredible human being. He is also one incredible professional. He is a person who has garnered the respect and admiration of his crew and everybody in the astronaut office. So, I want everybody to understand, Captain Mark Kelly is focused on flying, and he is focused on making sure that his crew stays safe and carries out the mission, to the best of their ability. That's my goal, to make sure that I facilitate their success in doing that. I will try my best to shield them from everything else that's coming.

It is an incredibly high-profile mission. But, we're going to do nothing any different than we did for STS–133 or STS–125 or anything else. If we have a problem, we won't go. So, I just want everybody to understand there's not going to be any special anything for STS–134, other than, it will be incredibly special to have Gabby at launch, because, to me, it represents the triumph of good over evil. So, I think it's incredible for the country, if she's able to make it there.

Senator MIKULSKI. Well, we share your emotion, we share your passion, and we share the hopes and dreams for this mission.

General BOLDEN. Thank you.

ADDITIONAL COMMITTEE QUESTIONS

Senator MIKULSKI. If there are no further questions—Senators may submit additional questions for the subcommittee's official record. We request that NASA respond within 30 days.

[The following questions were not asked at the hearing, but were submitted to the Department for response subsequent to the hearing:]

QUESTIONS SUBMITTED BY SENATOR DIANNE FEINSTEIN

LAUNCH CAPABILITY AND SAFETY

Question. I share your belief that we must engage our commercial space partners if we are to have a sustainable, fiscally responsible human space flight program in the years to come. This is especially true when we look at the costs and capabilities of the commercial and Federal rockets that were destined for low-Earth orbit (LEO).

What has been the total cost to the taxpayer to build the Falcon 9 (SpaceX), and how long did it take for the rocket to have a successful launch?

What was the total cost to the taxpayer for the Constellation program and how long did it take to achieve a successful launch?

Answer. The National Aeronautics and Space Administration (NASA) signed a Space Act Agreement with SpaceX for commercial cargo development services in August 2006 as part of the agency's Commercial Orbital Transportation Services (COTS) projects. The agreement with SpaceX established a series of technical milestones that would be paid by NASA once successfully achieved.

In June 2010, the company's first maiden flight of its Falcon 9 launch vehicle took place. (NOTE.—This flight was not covered by the COTS project milestones. The first demonstration flight under the COTS agreement with SpaceX took place in December 2010.) Therefore, the first maiden flight took place about 3 years after NASA signed an agreement with the company, with the presumption that SpaceX likely performed some initial design work on the Falcon 9 prior to the signing of the SAA with NASA.

With regard to taxpayer investment in the Falcon 9, SpaceX has multiple sources of cash that fund its Falcon 9 and Dragon development activities. These sources include payments from commercial customers, other Government agencies, other NASA programs, private equity financing, bank lines of credit, interest income, and cash from company reserves.

Although NASA does not have specific insight into the details of how NASA funds are being applied in SpaceX's company accounting system, in general, NASA's COTS agreement with SpaceX was specifically designed to help the company develop, demonstrate, and test the Falcon 9/Dragon. As of mid-May, NASA had paid SpaceX $298 million out of a potential $396 million for completing 25 of 40 negotiated SAA COTS milestones. Therefore, NASA is pleased that its investment to date has successfully helped support the development of both the Falcon 9 launch vehicle and the Dragon spacecraft and the ground infrastructure required for launch.

Additionally, it should be noted that NASA's International Space Station (ISS) program has made payments to SpaceX totaling $466 million for work performed under the Commercial Resupply Services Contract with SpaceX, and also that NASA's Launch Services Program also has made payments to SpaceX. Therefore, it is possible and likely that some of these NASA funds also have been used for Falcon 9 development as well.

As of April 2011, NASA had spent $12.9 billion on Constellation which includes funding for labor, infrastructure, acquisition, and development testing of hardware elements and software systems for all of the Constellation Projects Ares I and Ares V, Orion, Ground Operations, Mission Operations, EVA, etc. Therefore, drawing a direct comparison between SpaceX and Constellation's costs is a difficult task for several reasons: First, the SpaceX and Constellation transportation system are designed to support very different missions. The currently negotiated SpaceX milestones relate only to cargo transportation capability to the ISS and not crew transportation, whereas the Constellation architecture was being designed to provide crew and limited cargo transportation to the ISS, the Moon, and beyond. Therefore,

the Constellation system was being designed as a complete human launch capability (ground ops, launch vehicle, crew capsule, etc.) Second, SpaceX and NASA use very different business models with regard to personnel, infrastructure etc. For example, NASA was utilizing heritage hardware and infrastructure to build the Constellation architecture, as directed by law, and the agency also was developing a transportation architecture that was designed to employ shuttle contractors to a great extent, thereby mitigating contractor workforce loss following the retirement of the shuttle.

With regard to launches, the Constellation program, which was formally initiated in late 2005, did not achieve an orbital flight before it was canceled in 2011, but it had an active test program and had completed two key test flights prior to its termination, approved first by the NASA Authorization Act of 2010—the Ares I–X test flight in October 2009 and the Pad Abort I test for the Orion CEV on May 6, 2010.

Question. If the Heavy Lift Vehicle and MPCV were completed this year, could you send astronauts on missions to Mars? To Lagrange Points? Would these astronauts be safe from harmful radiation on a mission of this length?

Answer. NASA does not anticipate being able to conduct a Mars mission until at earliest the 2030 timeframe with the threat of deep-space radiation for crews during sustained human exploration beyond LEO needing to be resolved before such a mission could take place. NASA is continuing to conduct radiation research (both on the ground, and in-space aboard the ISS) and architecture and engineering solutions are aimed at developing the solutions and countermeasures necessary to safely execute these missions. The radiation mitigation solutions are planned and phased, much like the other key challenge areas, to produce the necessary capabilities when they are needed in the capability driven framework. A Mars mission duration is the horizon goal given the extended time period, so it is accordingly phased. However, a Lagrange Point (Earth Moon L–1 for example) is much closer and is viable given the current exposure levels and state of the art in technology/science. Radiation will remain an important enabling area for long-duration human spaceflight beyond LEO.

CONSTELLATION FUNDING

Question. Administrator Bolden, I recognize that we are here today to talk about the fiscal year 2012 budget, but there is still pressing work that must be done to complete the fiscal year 2011 spending plan. One issue I must raise is that the past six continuing resolutions have included a provision which prohibits your agency from cancelling any contracts related to the Constellation program. This program was terminated by both the Congress and the administration, but under these bills the NASA Inspector General says that the American people could be on the hook for $575 million in unnecessary costs.

I want to give you an opportunity to share your thoughts with this subcommittee on how we can eliminate this waste, and where we should redirect this substantial amount of funding?

Answer. Over the last year, due to provisions of the fiscal year 2010 Consolidated Appropriations Act (Public Law, 111–117)—restrictions that have since been rescinded in the fiscal year 2011 Full-Year Continuing Appropriations Act , NASA was prohibited from terminating any Constellation contracts. As such, NASA continued to implement the Constellation Program and associated projects, while at the same time prioritizing Constellation funding on work that was most related to the SLS and MPCV, thus maximizing use of taxpayer dollars.

When the inspector general's letter was issued on February 2, 2011, NASA agreed with its conclusion that said the Congress should take action as soon as possible to remove the limitations in the fiscal year 2010 Consolidated Appropriations Act regarding the Constellation architecture; such action by the Congress would enable NASA to redirect funds more efficiently to the SLS and MPCV. Additionally, we were pleased that the inspector general had recognized that: "NASA has taken steps to concentrate its spending on those aspects of the Constellation Program it believes many have future applicability, and that these efforts have helped to reduce the potential inefficient use of taxpayer dollars."

The attached white paper was developed in February 2011 to respond to queries from Members and staff about the inspector general letter prior to NASA having the authority to terminate unnecessary Constellation work.

NASA is currently developing a plan for the orderly close out of Constellation activities, with the goal of completing transition and close out of Constellation early this fall.

DEFORMATION, ECOSYSTEM, STRUCTURE AND DYNAMICS OF ICE (DESDynI) SATELLITE PROGRAM

Question. I was deeply troubled to learn that the fiscal year 2012 budget provides no funding for the DESDynI (pronounced "destiny") satellite program. This satellite would have provided NASA with unparalleled ability to monitor ground motion, and that capacity is critical to improving our understanding of earthquakes. This is not just my opinion, but the opinion of the National Academy of Sciences (NAS).

If the earthquake in Japan taught us any lesson, it is that we do not understand these events nearly as well as we once thought. So I question if this is an appropriate time to cancel the DESDynI program.

Administrator Bolden, how do you rationalize cutting this program given its high ranking in the NAS Decadal Survey and the clear need to improve our understanding of earthquakes?

Answer. NASA's Earth science program studies a broad range of phenomena related to climate, weather, and natural hazards, including earthquakes. NASA strives to maintain a balanced portfolio across these areas that is responsive to national needs, and informed by recommendations from the National Research Council (NRC). To that end, NASA continues with concept design work on the DESDynI mission, a tier 1 recommendation from the 2007 National Research Council's Earth Science Decadal Survey.

In March 2009, after more than a year of collaborative study involving the engineering and scientific research communities, NASA made the decision to implement DESDynI as a two-spacecraft mission (one carrying a radar payload, and one a lidar, both in orbit at the same time). This approach allowed the mission to provide maximum science information in support of the solid Earth, ecosystems, and polar ice communities. This approach was reviewed positively (for science content/value) by the Earth Science Subcommittee of the NASA Advisory Council. In the context of the President's fiscal year 2011 budget request and the 2010 NASA Climate Initiative Plan, DESDynI was being studied and activities were ramping up to support a launch in late 2017. The Climate Initiative Plan also includes launches of Aquarius in June 2011, the Orbiting Carbon Observatory-2 in February 2013, the Soil Moisture/Active-Passive mission in late 2014, the Orbiting Carbon Observatory-3 as an instrument of opportunity for flight in 2015, the Gravity Recovery and Climate Experiment (GRACE) Follow-On mission in 2016, and the Surface Water-Ocean Topography and Active Sensing of CO_2 Emissions over Nights, Days, and Seasons missions in 2019–2020. These other elements of the plan are funded in the fiscal year 2012 request, along with research activities in the Earth science program's Earth surface and interior focus area. These include crustal dynamics research conducted in coordination with United States Geological Survey to improve understanding of the forces that lead to earthquakes, volcanoes, and landslides.

By early calendar year 2011, the two-spacecraft DESDynI mission is in Pre-Formulation and has successfully passed its formal Mission Concept Review.

However, given the more constrained fiscal environment, NASA will be unable to move as aggressively as planned in the fiscal year 2011 request to manifest DESDynI. The fiscal year 2012 budget request provides sufficient resources to engage potential international partners on the radar mission, and NASA will evaluate whether contributions from partners can allow development of the radar mission alone for launch near the end of the decade within the overall Earth Science Division budget constraints. In addition, during fiscal year 2011–2012, NASA will work to identify an international contribution of the lidar portion of the mission.

NASA CENTERS

Question. I was greatly concerned to hear speculation about the closure of some small NASA Centers in response to budget cuts. NASA has three centers in California—Ames Research Center, Dryden Flight Research Center and the Jet Propulsion Lab—which provide more than 7,000 highly skilled, high-salary jobs in my State. These Centers also provide unique capabilities such as wind tunnels and arc jet testing for the aerospace industry in my State.

The prior NASA Administrator made a commitment to "10 healthy NASA centers" including those in California. Have you made or will you make that same commitment?

Answer. NASA has remained committed to the sustainment of its current complement of nine Centers and the Jet Propulsion Laboratory, each carrying out its mission in a well-functioning, effective manner. NASA is working to achieve a balanced portfolio, with each Center enjoying a vibrant engagement in its distinct areas of innovation and strength to support the agency's missions in science, exploration, aeronautics, and technology development.

Prior to enactment on April 15, 2011, of the fiscal year 2011 Full-Year Continuing Appropriations Act (Public Law 112–10), NASA leadership stated before the Congress that the $298 million reduction to NASA's Cross-agency budget, proposed in H.R. 1, would have an operational impact to the agency equivalent to the shuttering of two small NASA Centers. This reduction did not pass and none of the NASA Centers were closed.

In accordance with direction provided in the NASA Authorization Act of 2010 (Public Law 111–267), NASA is presently engaged in a careful examination of the agency's structure, organization and institutional assets, with the goal of identifying a strategy to evolve toward the most-efficient retention, sizing and distribution of facilities, laboratories, test capabilities and other infrastructure, consistent with NASA's missions and goals. The assessment of NASA's real property footprint at all of its Centers and facilities is also responsive to administration direction to executive departments and agencies regarding the disposal of unneeded and duplicative Federal real estate. As directed by Public Law 111–267, NASA will provide a report to the Congress on the results of its comprehensive study in fall 2011.

QUESTIONS SUBMITTED BY SENATOR MARK PRYOR

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION (NASA) EDUCATION

Question. NASA's fiscal year 2012 funding request for education totals $138.4 million. This request is $41.6 million less than enacted fiscal year 2010 levels and $7.4 million less than the authorized levels for fiscal year 2012.

The NASA Space Grant and Experimental Program to Stimulate Competitive Research (EPSCoR) programs are particularly impacted. These science, technology, engineering, and mathematics (STEM) programs help a large number of students and historically have had a good return on NASA's investment. The NASA Authorization Act authorized space grant at $45.6 million and EPSCoR at $25 million for fiscal year 2012.

Why is NASA proposing an almost 50 percent cut in combined funding for these two programs?

Answer. NASA's Office of Education will focus its funds on existing commitments and grant renewals, continuation of scholarships, internships and fellowships, and activities that directly serve educators, students, and the general public. The decrease will be managed by reducing the number of new grant awards and seeking operational efficiencies (e.g., increased use of education technologies, reduction in printing/warehousing/shipping costs, reducing travel, coordinating solicitations).

NASA's requests for Space Grant and EPSCoR funding have been relatively consistent for several years. The President's budget request for fiscal year 2012 reflects the need to develop a balanced education portfolio for the agency that supports its efforts in higher education, K–12 student and teacher programs, and informal education.

[Dollars in millions]

Program	Fiscal year 2010 PBR [1]	Fiscal year 2011 PBR	Fiscal year 2012 PBR
Space grant	28.4	27.7	26.5
EPSCoR	10	9.3	9.1

[1] In fiscal year 2010, NASA's Office of Education was appropriated additional funds to support increases to the budgets of these two projects.

We will make internal adjustments to the fiscal year 2011 Education portfolio in order to comply with the law as mandated.

Question. What is NASA's commitment to Space Grant and EPSCoR?

Answer. NASA remains committed to both Space Grant and EPSCoR. NASA initiated the National Space Grant College and Fellowship Program (Space Grant) in fiscal year 1989. Space Grant is a national network that expands opportunities for students, educators, and faculty to understand and participate in NASA's aeronautics and space projects. Space Grant is now composed of 52 consortia in 50 States, the District of Columbia, and the Commonwealth of Puerto Rico. Space Grant leverages the resources of more than 900 affiliates from universities, colleges, industry, museums, science centers, and State and local agencies. Space Grant supports and enhances science and engineering education and research efforts in higher education, K–12, and informal education. NASA establishes training grants with each consortium, aligning consortium work with the education priorities and the annual performance goals of the agency.

EPSCoR develops academic research enterprises that are long-term, self-sustaining, and nationally competitive by supporting States with modest research infrastructure so that they become more competitive in attracting non-EPSCoR funding. Funding is competitively awarded to lead academic institutions (in eligible States) to foster research and technology development opportunities for faculty and research teams. NASA actively seeks to integrate the research conducted by EPSCoR jurisdictions with the scientific and technical priorities being pursued by the agency. These scientific and technical priorities are established and evaluated by the agency's Office of the Chief Technologist and Mission Directorates. NASA's commitment to EPSCoR will be strengthened through alignment with the agency's new Space Technology Roadmaps.

TECHNOLOGY DEVELOPMENT PROGRAM

Question. In the late 1990s and early 2000s, NASA had a significant emphasis on developing game-changing technologies. That era brought such developments as National Aerospace Plane (NASP), X–33 and X–34 experimental Single Stage to Orbit (SSTO) Vehicles, and RS–84 LOX/RP engine, to name a few. These programs resulted in NASA spending billions of dollars without a single successful development. In the current budget submission you have a similar Technology Development Program with more than $1 billion of funding.

What is different in NASA's current Technology Development Program that gives us confidence it is not a repeat of past failures?

Answer. During SSTO initiatives, NASA learned that developing new launch vehicles using unproven subsystems will increase the overall risk of the mission. Additionally, when major technology development embedded within the development of a new vehicle, the schedule is longer and the cost is greater. This conclusion was outlined in March 2009 testimony before the House Science Subcommittee by a Government Accountability Office (GAO) representative who described GAO's analysis of 13 NASA flight projects in the implementation phase. In this project phase, systems design is completed, scientific instruments are integrated, and the flight system is fabricated and prepared for launch. Prior to entering the implementation phase, it is standard NASA practice to have finalized requirements, concepts and technologies and establish a baseline project plan. Of the 13 NASA projects in the implementation phase assessed by the GAO, 10 projects experienced significant cost and/or schedule growth from their project baselines. Of the five causes of cost and/or schedule growth cited by the GAO, two issues pertained directly to technology development risk: technology immaturity and modifications required to previously considered heritage items. The common symptom of these two causes is a technological readiness considerably below that estimated by the project. The GAO report concludes, "Simply put, projects that start with mature technologies experience less cost growth than those that start with immature technologies."

The Space Technology Program was formulated to mature the technologies required for NASA's future missions outside the major vehicle development programs. By advancing technology prior to vehicle development, space technology allows for NASA's future projects to take an acceptable level of risk, resulting in a more stable portfolio. Space technology is not developing vehicles as the former Office of Aerospace Technology (late 1990s and early 2000s) attempted. In contrast to the NASP, X–33 and X–34 programs, space technology's approach is similar to the approach NASA used in the Apollo era where it was conceiving Apollo technologies while developing/testing the Gemini hardware and flying the Mercury missions. NASA space technology funding will be spent to advance and mature critical subsystems through concept, design and testing. When proven, these technologies will be baselined for NASA's future missions, enabling greater capability and reducing the risk and cost of NASA's future missions.

As a specific example, consider the X–33. In this program, NASA attempted to test multiple conceptual technologies within a new vehicle design. One of these technologies was a conformal, composite, cryogenic tank that would reduce the amount of fuel required to reach orbit, thus reducing the cost per launch. Unfortunately, the X–33 composite cryotank had manufacturing challenges that delayed the rest of the X–33 test program, increasing program cost significantly. NASA chose to cancel the X–33 program, in part because the design and manufacturing process of the cryotank prevented this technology from being matured to flight readiness status. In today's space technology model, NASA would focus on maturation of the composite cryotank and other technologies before trying to incorporate them into the X–33 design. This approach prevents a single technology from holding up an entire integrated vehicle. Since the cancellation of X–33, NASA has had some success in composite cryotank tests conducted at the Marshall Spaceflight Center (in 2004). In-

dustry and academia have also made measurable progress in separate efforts. Unfortunately, due to limited and uncoordinated investments, NASA and the aerospace industry have not been able to fully mature this important technology in time to incorporate into current vehicle plans. Through the Space Technology Program, the agency will invest in this critical technology so that when it is mature it may be incorporated into future missions including future incarnations of the Space Launch System (SLS) and planetary landers.

Question. Please describe exactly what projects will be pursued under this program and why they are a vital need for taxpayer expenditures?

Answer. The fiscal year 2012 budget request for space technology provides a modest increase above the level projected in the NASA Authorization Act of 2010, consistent with the administration's priority on Federal investments in research, technology, and innovation across the Nation. These investments are critical for the agency's future, our Nation's future in space, and our Nation's technological leadership position in the world. Expanding this program is not only required to enable NASA's future missions in science and exploration, but doing so will build our Nation's economic competitiveness and create high-tech jobs. As noted by the National Research Council in numerous reports, NASA needs to make maturing transformative, high-payoff technologies a high priority if we are to see reductions in the cost and risk of the agency's future missions. While the request is above the authorized level for fiscal year 2012, NASA believes this amount is critical, and this is a top agency priority.

Within the fiscal year 2012 budget request, NASA has integrated management responsibility of two technology development programs included in the NASA Authorization Act under the Office of the Chief Technologist. In fiscal year 2012, funding for the Space Technology Program is proposed at approximately 5 percent of the administration's $18.7 billion request for NASA. As defined in the fiscal year 2012 budget request, the Space Technology Program consists of three major components, two of which are well-established. These three components, as listed in Table 1, are:

—the Small Business Innovative Research (SBIR)/Small Business Technology Transfer (STTR) program and related technology transfer and commercialization activities (fiscal year 2012 request: $284 million) funded in fiscal year 2010 and earlier through NASA's Innovative Partnership Program;

—a majority of the Exploration Technology Development and Demonstration activities (fiscal year 2012 request: $310 million) funded in fiscal year 2011 and earlier in the Exploration Systems Mission Directorate (ESMD); and

—the Crosscutting Space Technology Development activities, initially proposed as part of the President's fiscal year 2011 request (fiscal year 2012 request: $430 million). All components of space technology have been carefully formulated over the past year, and have deep roots in technology development approaches NASA has successfully pursued in previous years.

TRACE OF FY12 SPACE TECHNOLOGY CONTENT① ($ in millions and in full cost view)	FY 2010 Enacted	FY 2010 Actual	FY 2011 Authorization Act	FY 2011 Auth Act (in FY12 Structure)	FY 2012 Authorization Act	FY 2012 Auth Act (in FY12 structure)	FY 2012 PBR
TOTAL	327.2	275.2	600.0	512.0	923.3	796.0	1024.2
Innovative Partnerships Program	175.2	123.8⑤	350.0	175.2	486.0	175.2	284.0
Crosscutting Space Technology Development	0.0	0.0		174.8		310.8	430.2
Exploration Technology Development	152.0	151.4	250.0	162.0	437.3	310.0	310.0
	82.6④	87.2④		88.0④		127.3④	127.3④

NOTES:

① Space Technology content as defined in President's FY 2012 request (inclusive of the SBIR/STTR program and related innovation, technology transfer and commercialization activities funded in FY 2010 through NASA's Innovative Partnership Program, a majority of the Exploration Technology Development and Demonstration activities funded in FY 2010 in the Exploration Systems Mission Directorate, and the Crosscutting Space Technology Development activities initially proposed as part of the President's FY 2011 budget request).

② IPP merged into Space Technology in FY 2011. IPP FY 2010 Enacted levels are shown in FY 2011 and FY 2012 Auth Act split.

③ Sum of FY 2010 ETDP and planned FY 2011 ETDO efforts that are planned to move to Space Technology in FY 2012.

④ AES content requested within ESMD in FY 2012; not included in Space Technology total. Only includes Technology Infusion Projects; ISS Research ($46.8M) not included in this total.

⑤ SBIR/STTR transfer ($51.7M) to SMD with planned payback due to one year appropriated funds.

Table 1.—Fiscal year 2012 space technology content integrates the long-standing efforts of NASA's Innovative Partnership Program, Exploration Technology Development Program, and the crosscutting space technology activities first proposed in NASA's fiscal year 2011 budget request.

Relative to fiscal year 2010 enacted levels, an increase of $109 million is requested for the SBIR/STTR and related innovation, technology transfer, and commercialization activities formerly associated with the NASA Innovative Partnership Program. Small businesses have generated 64 percent of net new jobs over the past 15 years. A significant fraction of this increase is targeted for the small business community, directly fueling the number of high-tech jobs that small businesses create in America. Additional funds are also planned to expand NASA's efforts in transferring and commercializing NASA-developed technologies into the private sector.

Relative to fiscal year 2010 enacted levels, an increase of $158 million is proposed for Exploration Technology Development activities formerly budgeted within ESMD. This increase is consistent with the authorization act. This component of space technology funds activities largely at the NASA Centers that are critically focused on NASA's beyond low-Earth orbit (LEO) exploration priorities. In order to meet the exploration goals established in the NASA Authorization Act of 2010, NASA needs to develop the mission-specific capabilities required for its future exploration missions. Exploration technology development investments will benefit future adaptations of the Multi Purpose Crew Vehicle (MPCV) and the SLS and form the basis for the in-space transportation systems required for deep space exploration.

Relative to the NASA Authorization Act of 2010, an increase of $120 million is requested for NASA's Crosscutting Space Technology Development activities. Focused on broadly applicable, high-payoff technology that industry cannot tackle today, NASA's Crosscutting Space Technology Development activities mature the technology required for NASA's future missions in science and exploration while proving the capabilities and lowering the cost of other Government agency and commercial space activities. As evidenced by more than 1,400 Requests for Information responses, more than 300 external participants at the July 2010 Industry Day Forum, and a relatively large number of letters and opinion editorials, there is a large community of innovators throughout the Nation interested in working with NASA on Crosscutting Space Technology Development activities. Consistent with the NASA Authorization Act of 2010, these efforts are guided by a strategic set of technology roadmaps, available today in draft form and presently under review by the National Research Council (NRC). The NRC's final report from external review of the draft NASA Space Technology Roadmaps is scheduled for release in January 2012 (with a preliminary report scheduled for September 2011) in time to guide the fiscal year 2012 space technology competition-based acquisition process.

NASA has identified a series of ongoing, high-priority, mission-focused space flight technology development activities, led by the NASA Centers, to address known capability gaps and deficiencies to achieve the science and exploration goals set by the Congress in the NASA Authorization Act of 2010. Each of these technologies, once matured, will reduce mission cost and risk. As an example, in fiscal year 2011, the following ongoing technology activities have been prioritized:

Spacecraft Servicing.—Continuing the ongoing development of robotic satellite servicing technologies such as end effectors, refueling systems, autonomous rendezvous and docking sensors and algorithms and tools, enabling robotic and human exploration mission architectures and demonstrating the commercial utility for servicing satellites.

Optical Communications.—Continuing the fiscal year 2010 effort, an advanced ground receiver and designs for flight hardware capable of providing a high-bandwidth downlink will be developed, enabling future beyond LEO exploration.

Composite Cryotanks.—Continuing fiscal year 2010 efforts, large-scale (5 meters and up to 10 meters in diameter) composite cryogenic propellant tanks will be developed and tested, decreasing the mass of future enhancements to the SLS and other in-space systems (e.g., lander systems).

Inflatable Aerodynamic Decelerators.—Continuing fiscal year 2010 efforts, develop and demonstrate hypersonic inflatable aeroshell technology suitable for an ISS down-mass capability and deep space exploration, and supersonic decelerator technology suitable for future Mars missions.

Space Robotics, Propulsion, and Autonomous Systems.—Continuing fiscal year 2010 efforts, advance robotics technology amplifying human productivity and the effectiveness of human-robot teams, test nano-propellants, and develop advanced propulsion technologies increasing the performance of future launch and in-space systems, and mature autonomous space system capabilities.

Space Flight Technology ISS Demonstrations.—Microgravity fluid dynamics and materials characterization testing on the ISS providing data to aid in the design of propellant management devices and structures of future in-space systems.

Commercial Reusable Suborbital Research.—Continuing fiscal year 2010 efforts, flight demonstration tests of at least two commercial reusable suborbital vehicles and development and/or integration of at least four suborbital technology payloads to stimulate the emerging commercial reusable suborbital research industry.

These ongoing activities as well as those projects currently managed by ESMD in exploration technology will continue to be funded in fiscal year 2012 through space technology. In addition to these agency priorities, NASA will competitively award, high-priority space flight technology development activities that engage the NASA Centers, industry and academia in reducing the risk and/or cost of NASA's future space flight missions. A limited number of competitively selected awards are anticipated in fiscal year 2011 for the Space Technology Research Fellowships, NASA Innovative Advanced Concepts, Game Changing Development and Technology Demonstration Missions solicitations. Spaceflight technology development projects focus upon key agency technology priorities identified in recent human spaceflight mission architecture studies, benefiting future enhancements of the SLS and MPCV and forming the basis for some of the additional spaceflight systems required for beyond LEO exploration. In some cases, these same activities will mature capabilities that are also required for future Science missions identified in NRC decadal surveys. These activities have deep roots in technology development approaches NASA has successfully pursued in previous years.

Question. In the current time of needed spending cuts and fiscal constraint, does it make financial sense to spend more than $1 billion on far-in-the-future projects that may never be realized or could that money be better spent on current programs with tight budgets?

Answer. Space technology is the central NASA contribution to the President's revitalized research, technology, and innovation agenda for the Nation. These investments will produce cutting edge technological advances within 1–3 years, making dramatic improvements in technology areas such as propulsion, cryogenic storage, closed-loop life support, and avionics that could reduce the cost of future space missions by up to 80 percent. As an integral component of its Space Technology efforts, NASA plans to invest in small business innovative research and technology development—money that will directly fuel the number of jobs that small businesses create in America. Small businesses have generated 64 percent of net new jobs over the past 15 years, leading the innovation push into the future.

Not only do these technologies benefit NASA's line of work, but NASA's research and development has also been shown to stimulate new business lines that create future jobs. This is validated in "Rising Above the Gathering Storm: Energizing and Employing America for a Brighter Economic Future" by the Committee on Prospering in the Global Economy of The 21st Century, chaired by Norman R. Augustine. NASA has provided numerous achievements in the fields of aeronautics, electronics, computers, aerospace systems, health technology, imaging detectors, telescopes, and high-performance materials, for example. These technologies for NASA's science and engineering achievements are transferred into the Nation's economy through industries that apply them in innovative ways. The Augustine Committee reported that research and development investments, like those that NASA's missions require, have "social rates of return from 20–100 percent, with an average of 50 percent."

We recognize the important work the Congress is undertaking to simultaneously balance the Nation's checkbook, stimulate job growth and maintain our global competitiveness. The President's fiscal year 2012 budget request for space technology is consistent with NASA Authorization Act of 2010 and the administration's priorities on Federal investments in research, technology and innovation across the Nation. A renewed technology emphasis balances NASA's long-standing core competencies of research and technology, spaceflight hardware development, and mission operations. With commitment from the Congress, the investments outlined in NASA's fiscal year 2012 budget request for space technology could yield many thousands of jobs in this country making this an ideal time to increase our investment in these activities. The creation of new products and services, new business and industries, and high-quality, sustainable jobs will attract bright minds into educational and career paths in STEM, adding to the Nation's technological leadership and leaving a lasting imprint on the economic, national security, and geopolitical landscape. Through these technological investments, NASA and our Nation will remain at the cutting-edge while advancing technology components NASA needs to reach our exploration objectives.

QUESTIONS SUBMITTED BY SENATOR SHERROD BROWN

UNPUBLISHED TEST REQUIREMENTS DOCUMENT

Question. In the Commercial Crew Transportation System Certification Requirements for National Aeronautics and Space Administration (NASA) Low Earth Orbit Missions (ESMD–CCTSCR–12.10) document (dated December 2010), you cite MIL–STD–1540E, "Test Requirements for Launch, Upper-Stage, and Space Vehicles" as a fully applicable document. As of this time, MIL–STD–1540 rev E has not been published. How is an unpublished document capable of being fully applicable to Human Rating Standards? In the absence of the actual document, to what standard are the CCDev/CCDev2-developed vehicles being held?

Answer. The National Aeronautics and Space Administration (NASA) expected the MIL STD–1540 E to be released in December 2010 which is why it was included in ESMD–CCTSCR–12.10. NASA has since evaluated the SMC Standard SMC–S–016 (2008) and found this published document to be a more comprehensive test document that covers the content of MIL STD–1540 E.

ESMD–CCTSCR–12.10 is planned to be revised later this year. The revision will reflect SMC–S–016 (2008). References to MIL–STD–1540E will be deleted. NASA draft requirements documents were provided to CCDev/CCDev2 participants for consideration in developing their system concepts; however, NASA is not imposing requirements or standards on participants as part of the CCDev/CCDev2 activity.

FEASIBILITY OF DEVELOPING COMMERCIAL CREW CAPABILITY

Question. The Aerospace Corporation recently published a feasibility study for Commercial Crew which was highly critical of NASA's current plans. In fact, it stated that given the current assumptions, development and operations of commercial crew capability may cost NASA $10 billion–$20 billion for one viable commercial crew provider, and still result in prices per seat of two to three times as much of current foreign-based alternative access options. What is your response to this?

Answer. The Aerospace analysis referenced is this question is one of many analyses about the business case for commercial crew that have been generated over the years. However, NASA believes the Aerospace analysis cannot be used for assessing the commercial crew business case or potential costs for crew launches because any definitive analysis of the business case for commercial crew must come from the companies themselves, not from NASA or the Aerospace Corporation, and such analysis must surely include proprietary, realistic data inputs from the companies themselves.

Aerospace has recognized the limitations of its hypothetical-based analysis with the following statement which they released publicly in April 2011:

"The intent of this report was not to pass judgment on the economic feasibility of a commercial crew transportation provider, but rather to illustrate the ability of the tool to conduct parametric sensitivity studies . . . The results shown to NASA and Congress recently were not intended to represent any specific real-world scenario. We modeled a scenario utilizing data from as long as 10 months ago in order to demonstrate the tool's viability, not the viability of any specific commercial crew transportation system."

When conducting its analysis, Aerospace developed its own model inputs regarding things such as cost, schedule, and price of launch services rather than asking NASA or companies for inputs for the Aerospace analysis. Thus, Aerospace's report was based on hypothetical versus real-world inputs from potential commercial crew providers.

EARTH DEPARTURE STAGE (EDS) AND LANDER DEVELOPMENT

Question. Development of Orion is potentially continuing as Multi Purpose Crew Vehicle (MPCV), so crew capability to some destination beyond low-Earth orbit (LEO) is still being developed. Planning and budgeting for the Space Launch System (SLS) has begun. But there is no money in the budget—now or in the near future—to plan for or develop an EDS or a lander. What is your plan regarding both of those vehicles which are necessary to reach whatever final destination is chosen?

Answer. NASA architecture studies are ongoing and consistent with a capabilities driven framework. These analyses include plans for an Upper Stage, Cryo Propulsion Stage (CPS), or EDS, as well as landers of various types and configurations, based upon the destination requirements. Commonality assessments are also being done to ascertain whether common components, subsystems, or systems can be used across the portfolio. NASA is currently studying whether the SLS Upper Stage can be the same as the CPS or EDS, depending upon performance and mission require-

ments. By assessing commonality and basic system architectures now, NASA can further evaluate and plan for leveraged development and production, as well as, reduced risk and increased economies of scale benefits for these other critical systems and elements. Focused technology development activities in both the Advanced Exploration Systems (AES) within the Exploration Systems Mission Directorate and the Space Technology Program are planned consistent with the architecture and capability priorities. Finally, ongoing dialogues with the international and interagency communities are continuing to explore potential cooperation areas for key systems or potentially entire elements for these systems.

In the meantime, while planning for SLS and MPCV continues, our civil servants across the agency should feel confident that there is exciting and meaningful work for them to do following the retirement of the shuttle and the transition from Constellation, and the shift from assembly of the ISS toward ISS operations. Turning our focus toward a more capability-driven exploration architecture will offer far-ranging opportunities for our creative and skilled civil servant workforce across the agency. There will be opportunities for them to apply their cross-cutting talents to new challenges such as developing and demonstrating prototypes for human capabilities needed for beyond-LEO exploration. Here are just a few examples of enabling capabilities that must be developed before we can send crews beyond LEO—work that will be managed by our new AES program:

—Developing a ground-based test bed for demonstrating life support systems needed to enable long-duration crewed missions based on lessons learned from operation of the life support systems currently in use on the ISS;

—Developing and testing components for an advanced spacesuit to improve the ability of astronauts to assemble and service in-space systems, and to explore the surfaces of the Moon, Mars and asteroids;

—Developing design concepts for future space exploration vehicles and deep-space habitats; and

—Conducting ISS and ground-based analog testing to validate operational concepts for long-duration missions.

We have already employed this teaming approach quite successfully, as exemplified by the NASA in-house efforts with Robonaut2 (R2), which was delivered to the ISS on the last space shuttle flight. This robot was developed in partnership by a joint NASA-General Motors team. Another example is the Lunar Electric Rover, which is a pressurized surface rover to provide astronaut mobility for exploring a planetary body in a shirtsleeve (or nonspacesuit) environment. The prototype, developed at low-cost, has already been demonstrated and matured through field testing at sites on Earth that resemble the lunar terrain, for example. The rover, along with some of NASA's astronauts, also participated in President Obama's Inaugural Parade. In sum, both of these examples highlight the substantial benefit we will continue harnessing from our highly creative, competent and mission-focused workforces across the agency and at all centers.

COLLABORATION WITH THE FEDERAL AVIATION ADMINISTRATION (FAA) AND THE U.S. AIR FORCE

Question. NASA, FAA, and the Air Force Research Laboratory (AFRL) held a productive technical conference at Wright-Patterson Air Force Base to examine safety issues behind the integration of Unmanned Aerial Systems into the National Airspace System (NAS). What were the major outcomes and what plans do you have to continue this work with FAA and the AFRL?

Answer. The workshop explored the potential of the Unmanned Aircraft Systems (UAS) mission, together with the research and development (R&D) capabilities and plans of the organizations involved in addressing UAS access to the NAS. In designing the workshop, NASA, FAA, and AFRL established three primary objectives. The first was to identify the set of technical issues that must be resolved in order to ensure safe and consistent UAS operations in future airspace. The second objective was to catalog current R&D activities by each represented Government agency and identify gaps not currently being addressed. The third objective was to identify areas where joint demonstrations can advance progress toward UAS integration more effectively than single-agency efforts.

The workshop was divided into three technical teams:

—Air vehicles;

—Sense and avoid and communications; and

—Human factors and ground control station.

The teams focused their efforts on supporting R&D requirements for 2018 and beyond in order to achieve UAS integration and operations into the next generation airspace. Each track identified major "long poles" or critical technical challenges, as

well as technology gaps, which are currently impeding routine UAS access to the NAS. These were reported at the conclusion of the meeting.

Since the workshop, a plan has been developed by the member agencies of the Joint Planning and Development Office to establish a Research, Development and Demonstration (RD&D) Roadmap (referred to as the UAS Research Management Plan [RMP]) to guide the multi-agency work and cross-collaboration. Four tracks have been established to work the issues with representatives from key stakeholder agencies (NASA, Department of Defense, FAA, and Department of Homeland Security) participating as appropriate:

—Ground control station human factors;
—The unmanned vehicle;
—Airspace operations; and
—Communications.

In order to build the Risk Management Program, the partner agencies have formed Technical Tracks, in which senior research managers from each agency work together to:

—Identify the most critical technology and policy issues (R&D needs and challenges), taking into account UAS ConOps provided by the partner agencies.
—Identify current and planned RD&D activities by the partner agencies.
—Indicate the dates when series of activities are initiated and completed (on and off ramps).
—Identify linkages between these activities including dependencies in terms of entry criteria (prerequisites) and exit criteria (minimum required deliverables).
—Provide estimates of activity costs where such information is available and publicly releasable.
—Identify current plans or strong opportunities for interagency joint R&D or demonstrations.

This initial UAS RMP will be completed by the end of fiscal year 2011 and will provide the path forward for collaborative UAS research, development, and demonstrations across relevant Federal agencies. This will be the basis for a more comprehensive plan involving industry, academia, and other government agencies to ultimately provide routine UAS access to the NAS.

Question. Both NASA and the Air Force conduct research in aeronautics and space, and there is a long history of NASA and the Air Force working together on problems of mutual concern. Now, in an era of particularly tight budgets, it becomes even more important for these agencies to work together. Please describe your plans to work closer with AFRL in both aeronautics and space. In particular, can both the Air Force and NASA support the commercialization opportunities of the other?

Answer. NASA and the Air Force have opportunities to collaborate in specific programs as well as general collaboration in the commercialization of technology emerging from their respective agencies. At the NASA Center level, there are areas of technology development including propulsion, power generation and energy storage, alternate fuels, remote sensing, communications, robotic and UAV operations, sensor technology, advanced battery development, human factors R&D, advanced materials development, imaging technology, hypersonics, subsonic fixed wing research, and technologies associated with improving the environmental footprint of existing and future aircraft etc., that have corollary applications for Air Force mission operations as well as terrestrial commercial applications.

In terms of collaboration with Air Force management, NASA Chief Technologist Dr. Robert Braun met with the Air Force Chief Scientist Dr. Mark Maybury to discuss strategic plans and possible synergies between our S&T programs. NASA's Office of the Chief Technologist (OCT) cross-walked the draft NASA Space Technology Roadmap technology needs with the "Air Force Report on Technology Horizons—A Vision for Air Force Science and Technology During 2010–2030" and identified about 80 potential collaboration areas. NASA is currently identifying the top 15 areas for collaboration, and will ask the Air Force Chief Scientist and the Deputy Assistant Secretary of the Air Force for Science and Technology to identify their top 15. In addition, NASA's OCT and the AFRL are looking into possible collaboration for technological development or demonstration in the areas of solar electric propulsion, hydrocarbon boost, and space access.

These activities build on ongoing partnerships between NASA and AFRL. The joint NASA/AFRL/FAA Commercial and Government Responsive Access to Space Technology Exchange (C/RASTE) is specifically designed to help with commercialization opportunities. The third annual C/RASTE meeting will occur in October 2011 in Atlanta, Georgia. NASA and AFRL have also partnered to gather industry input from 32 commercial firms and develop a roadmap of technology priorities of interest to industry for developing commercial reusable launch vehicles. As our partnership strengthens, we anticipate that NASA and the Air Force will mutually sup-

port the significant commercialization opportunities for our respective assets, expertise, and technology.

In the area of aeronautics, collaborative efforts exist between several NASA research centers (Ames, Dryden, Glenn, and Langley) and both the AFRL and the Office of Scientific Research. Many of the aeronautics technologies (hypersonics, subsonic, fixed wing, etc.) have military applications as well as potential civil applications, both of which could lead to commercialization opportunities. Collaborative opportunities are identified and discussed at various levels (between technical/engineering peers as well as project/program/senior management) and in a number of different venues. In particular, NASA and Air Force leadership regularly meet as members of the NASA/Air Force Executive Research Committee and the Versatile, Affordable, Adaptable Turbine Engine Steering Committee to assess research accomplishments and challenges, current activities, and future collaboration plans. In addition to these research collaborations, through the National Partnership for Aeronautical Testing, the Air Force and NASA have put in place a joint technology development program to address future test techniques and instrumentation which involves NASA, the Air Force Arnold Engineering Development Center, and AFRL.

SCIENCE, TECHNOLOGY, ENGINEERING, AND MATHEMATICS (STEM) EDUCATION

Question. One of the major problems facing science organizations like NASA and AFRL—as well as the private sector—is the need for STEM education at all levels. Last year, NASA partnered with AFRL for a STEM symposium aimed at minority students. What additional plans do you have to promote STEM education to ensure that the rising generation of Americans has the scientific and technical skills we need to maintain NASA?

Answer. In January 2011, President Barack Obama stated that, ". . . over the next 10 years, nearly one-half of all new jobs will require education that goes beyond a high school education. And yet, as many as a quarter of our students aren't even finishing high school. The quality of our math and science education lags behind many other nations. America has fallen to ninth in the proportion of young people with a college degree. And so the question is whether all of us 'as citizens and as parents' are willing to do what's necessary to give every child a chance to succeed." This speech echoes findings and calls-to-action by numerous committees, reports, professionals in education, and leaders in American industry. In response, the Department of Education has identified several strategies to improve STEM education and ways in which Federal agencies can contribute to the Nation's STEM improvement efforts. NASA is a strong contributor to the national plan.

Consistent with section 202 of the America COMPETES Reauthorization Act of 2010, NASA works with professional organizations, academia, and State/local education providers to identify and address needs in STEM education. Quality professional development for STEM educators is a prevalent need. Through the education staff at NASA's centers, NASA works cooperatively with States and school districts to identify content needs and opportunities, and with university partners to ensure that NASA investments will be effective in improving teaching practice. NASA also works through communities of practice to identify content areas and special events that supplement informal education programming offered by museums and science centers. NASA higher education efforts increasingly target community colleges, which generally serve a high proportion of minority students. NASA programs build student STEM ability, preparing students for study at a 4-year institution. Competitive opportunities support initiatives like the President's "Race to the Top" and the Department of Education's "Star Project," which promote State-based education reform and identify replicable strategies for improving K–12 education.

NASA's education programs aim to increase the number of students who are proficient in, choose to major in, and pursue careers in STEM fields. Improving STEM ability, increasing public scientific literacy, increasing the talent pool of future STEM workers, and developing the STEM skills of the future workforce are imperatives if the Nation is to remain globally competitive and sustain a strong economy. NASA actively works through mutually beneficial relationships with more than 500 colleges and universities, hundreds of K–12 schools and districts, and more than 400 museums and science centers to provide education experiences, so that all students can learn deeply and think critically in STEM disciplines. NASA supports cutting-edge undergraduate student research that contributes to NASA missions while training the next generation of scientists, engineers, and innovators. NASA targets recruitment and retention of underserved and underrepresented students, including women and girls, Hispanics, and students with disabilities.

NASA is committed to providing equal access to its education activities by providing any student with the opportunity to contribute to the future STEM work-

force. NASA is responding by focusing its education investments on areas of greatest national need and ensuring that the agency's education programs support national STEM priorities. With its wealth of science and technology content and its expansive network of education professionals, NASA is well-equipped to address national needs such as meeting State requirements for educator professional development. NASA provides practical experience and skills development for those who will become the future workforce through internships, fellowships, and student research opportunities. NASA is especially qualified to attract students to pursue STEM study and careers. NASA is also able to engage these future workers through inspiring NASA missions, fostering collaborative relationships between students and the current workforce and offering students opportunities to work in "out of this world" facilities. Hands-on challenges with expert mentors generate increased interest in STEM study.

NASA has engaged students and teachers in its engineering challenges and scientific discoveries since its inception. From school presentations to seeds flown in space, from filmstrips and posters to podcasts and virtual tours through the galaxies, NASA's education programs have fostered inquiry, built curiosity, and encouraged innovation. Generations of Americans have participated in NASA's STEM education programs, and thereby learned basic skills, discovered new career paths, and developed interests in emerging academic disciplines.

NASA is actively engaged in collaborations with other Federal agencies to ensure the agency's programs are supportive of national STEM priorities. The NASA Associate Administrator for Education represents the agency on the National Science and Technology Council Committee on STEM Education (CoSTEM). It was established pursuant to the requirements of section 101 of the America COMPETES Reauthorization Act of 2010. The NASA Office of Chief Scientist is also participating in the CoSTEM by providing the CoSTEM Executive Secretary, who works in close coordination with the Office of Education.

NASA's Earth and space science missions have an essential role in NASA's education mission. The discoveries and new knowledge from our missions and research programs consistently engage people's imaginations, inform teachers, and excite students about science and exploration. We are committed to utilizing our resources to foster the broad involvement of the Earth and space science communities in education and public outreach with the goal of enhancing the Nation's formal education system and contributing to the broad public understanding of science, mathematics and technology. NASA's Science Mission Directorate creates education products using NASA's results in Earth-Sun system science, solar system research, universe exploration, and the development of new technologies to support learning. Through a "Train the Trainer" model the SMD programs train master teachers, who reach their peers via in person and online professional development opportunities that range from 1-day to week-long workshops. Another aspect of Teacher Professional development includes providing summer research opportunities for in-service teachers.

In 2010, NASA chartered an Education Design Team (EDT) to develop a strategy to improve NASA's education offerings, assist in establishing goals, structures, processes, and evaluative techniques to implement new sustainable and innovative STEM education programs. EDT has completed its task, and its recommendations are reflected in the fiscal year 2012 education budget for NASA's Office of Education.

The fiscal year 2012 budget provides NASA with the resources necessary to continue this rich tradition in STEM education through support for the Nation's students and educators, the leveraging of cutting-edge education technologies, and partnerships with industry. The budget proposal will:

—Increase NASA's impact on STEM education by further focusing K–12 efforts on middle school pre- and in-service educator professional development;
—Increase emphasis on providing experiential opportunities for students, internships, and scholarships for high school and undergraduate students;
—Emphasize evaluation and assessment, including external independent evaluation, to ensure that investments are providing desirable STEM impacts;
—Engage strategic partners with common objectives and complementary resources; and
—Use NASA's unique missions, discoveries, and assets (e.g., people, facilities, education infrastructures) to inspire student achievement and educator teaching ability in STEM fields.

CROSS-AGENCY SUPPORT (CAS) BUDGET

Question. Could you please detail the importance of the CAS portion of your budget, and for what specifically that part of the budget is used?

Answer. NASA's CAS funding provides critical mission-support activities that are necessary to ensure the efficient and effective operation and administration of the agency. These important functions align and sustain institutional and program capabilities to support NASA missions by leveraging resources to meet mission needs, establishing agency-wide capabilities, and providing institutional checks and balances. CAS includes two primary elements:

—Center management and operations (CMO); and

—Agency management and operations (AMO), which are detailed below.

CMO

CMO funds the critical ongoing management, operations, and maintenance of nine NASA centers and major component facilities. NASA centers provide high-quality support and the technical engineering and scientific talent for the execution of programs and projects. CMO provides the basic support required to meet internal and external legal and administration requirements; effectively manage human capital, information technology (IT), and facility assets; responsibly execute financial management and all NASA acquisitions; ensure independent engineering and scientific technical oversight of NASA's programs and projects in support of mission success and safety considerations; and, provide a safe, secure, and sustainable workplace that meets local, State, and Federal requirements. CAS also funds salary and benefits for civil service employees at NASA centers who are assigned to work on CMO projects. In addition, the account contains Center-wide civil service personnel costs, such as institutionally funded training.

AMO

AMO funds the critical management and oversight of agency missions, programs and functions, and performance of NASA-wide activities, including five programs:

—Agency management;

—Safety and mission success;

—Agency Information Technology Services (AITS);

—Strategic Capabilities Assets Program; and

—AMO civil service labor and expenses.

AMO supports executive-based, agency-level functional and administrative management requirements, including, but not limited to:

—Health and medical;

—Environmental;

—Logistics;

—General counsel;

—Equal opportunity and diversity;

—Internal controls;

—Procurement;

—Human resources; and

—Security and program protection.

AMO provides for the operational costs of headquarters as an installation; institutional and management requirements for multiple agency functions; assessment and evaluation of NASA program and mission performance; strategic planning; and, independent technical assessments of agency programs.

Safety and Mission Success activities are required to continue improving the workforce, and strengthening our acquisition processes, including maintaining robust checks and balances, in order to improve the safety and likelihood of mission success for NASA's programs throughout their lifecycles. The engineering, safety and mission assurance, health and medical independent oversight, and technical authority components are essential to NASA's success. They were established or modified in direct response to several major Government accident and mission failure investigation findings in order to reduce the likelihood of loss of life and/or mission in our human and robotic programs. The budget request also supports operation of three activities that each provides a unique focus in support of the independent oversight and technical authority implementation:

—the Software Independent Verification and Validation program;

—the NASA Engineering and Safety Center; and

—the NASA Safety Center located at the Glenn Research Center.

AITS encompasses agency-level cross-cutting services and initiatives in Information Technology (IT) innovation, business and management applications, and infrastructure necessary to enable the NASA mission. AITS includes management of NASA's scientific and technical information; identity, credential and access manage-

ment services; overarching information security services; enterprise-level business systems; and other agency operational services, such as email, directory services, and enterprise licenses. NASA's Security Operations Center will continue to mature capabilities to improve security incident prevention, detection, response, and management. NASA will continue implementation of major agency-wide procurements to achieve:

—consolidation of IT networks leading to improved network monitoring, management and reliability;
—consolidation of desktop/laptop computer services and mobile devices to achieve improved security and enable NASA Centers and programs to realize improved efficiencies;
—consolidation of agency public Web site/application management to improve the agency security posture and to facilitate access to NASA data and information by the public;
—minor enhancement and maintenance of integrated agency business systems to provide more efficient and effective agency operations; and
—reduction in overall agency data centers and related infrastructure currently funded outside the AITS budget.

The Strategic Capabilities Assets Program (SCAP) funds key agency test capabilities and assets, such as an array of flight simulators, thermal vacuum chambers, and arc jets, to ensure mission success. SCAP ensures that assets and capabilities deemed vital to NASA's current and future success are sustained in order to serve agency and national needs. All assets and capabilities identified for sustainment either have validated mission requirements or have been identified as potentially required for future missions, either internally to NASA or by other Federal entities.

AMO civil service labor and expenses funds salary and benefits for civil service employees at NASA headquarters, as well as other headquarters personnel costs, such as mandated training. It also contains labor funding for agency-wide personnel costs, such as agency training, and workforce located at multiple NASA centers that provide the critical skills and capabilities required to execute mission support programs agency-wide.

QUESTIONS SUBMITTED BY SENATOR THAD COCHRAN

ROCKET PROPULSION TEST INFRASTRUCTURE

Question. Your written testimony references the importance of investment in a 21st Century Launch Complex. As you know, before a new Heavy Lift Vehicle can be launched, it must first be tested extensively to ensure the safety of our astronauts and others. Given the National Aeronautics and Space Administration's (NASA) interest in safety, are we making investments in testing infrastructure that are commensurate with the updates to launch infrastructure? What activities will take place during fiscal years 2011 and 2012 toward improving our rocket propulsion test infrastructure?

Answer. Beyond funds for normal operations, NASA's initial fiscal year 2011 Operating Plan identifies $6 million to begin replacement of the Stennis Space Center High Pressure Industrial Water (HPIW) distribution system and $15 million to continue construction of the SSC A–3 test stand in fiscal year 2011. In fiscal year 2012, NASA has identified an additional $10 million to continue the HPIW replacement and is planning on $42 million for the A–3 test stand. Additional funds for fiscal year 2011 were planned to begin refurbishment of critical propulsion test infrastructure, but has been put on hold pending decisions on the Space Launch System (SLS) architecture decisions. Launch system design and requirements will be mapped to the appropriate capabilities, which will define the investments required for the propulsion test infrastructure.

Question. Are any NASA funds currently being used to support the construction, rehabilitation, or otherwise invest in rocket propulsion test infrastructure not owned by the Government? Are there any plans to do so in fiscal year 2012?

Answer. No NASA funds are currently being used or planned to support construction, rehabilitation, or otherwise invest in rocket propulsion test infrastructure not owned by the Government.

Question. Given the uncertainty that accompanied the fiscal year 2011 budget process, have there been specific delays toward achieving the goal of developing a 130-ton heavy lift vehicle? When do you expect to launch a 130-ton vehicle?

Answer. Delays in the fiscal year 2011 budget have not caused actual delays with the SLS development efforts, but it has caused inefficiencies. Primarily, our fiscal year 2011 activities have been dedicated to completing analysis, trades, and devel-

oping an acquisition strategy, which we continued to do while awaiting final fiscal year 2011 appropriations.

NASA's SLS development effort is focusing initially on the 70 to 100 mT lift capability. We also are seeking ways to capitalize on synergies between the lower-range and upper-range lift capabilities, thereby allowing us to develop some of the upper-range capabilities at the same time as we are focusing on the 70 to 100 mT capability. Doing so is actually a fairly natural, evolvable progression in terms of developing these capabilities. However, before making any final decisions, we must first understand how our approaches to heavy-lift will fit within the budget profile, how they will be affordable and sustainable over the long term, how they will fit into future exploration architecture, and how they might benefit other agencies to maximize the investment for the taxpayer.

NASA is currently in the process of running budget exercises to determine the implications of various potential budget scenarios, and thus creating development schedules to fit those associated budget profiles. Ultimately, we must plan and implement an exploration enterprise with costs that are credible and affordable for the long term under constrained budget environments. As such, our development efforts also will be dependent on a realistic budget profile and sufficiently stable funding over the long term, coupled with a successful effort on the part of NASA and our eventual industry team to reduce costs and to establish stable, tightly managed requirements.

In the coming weeks, NASA will be refining the SLS concept and defining strategy alternatives based on detailed Government analysis and completed input from industry through Broad Agency Announcement study contracts. Due diligence will ensure the best value for the taxpayer with respect to cost, risk, schedule, performance, and impacts to critical NASA and industrial skills and capabilities. Further details about NASA's analysis and decisions regarding SLS and MPCV and their integrated path forward will be provided to the Congress in a report in the late spring/summer timeframe.

STENNIS SPACE CENTER

Question. Your deputy, Lori Garver, visited Stennis Space Center on March 10 of this year. I personally appreciate the continued attention you and your staff give to the NASA capabilities along the gulf coast. In one of the news reports following her visit, Ms. Garver called Stennis a "unique facility for the government" that should be "fully utilized." Do you share Ms. Garver's view that Stennis' identity as a "Federal city" makes it a unique asset for the American taxpayer in terms of efficiency and cooperation?

Answer. Each of NASA's nine centers has unique capabilities that ensure our ability to achieve the goals of a portfolio of challenging by exciting missions. The Stennis Space Center possesses several unique capabilities and assets of which the American taxpayer can be proud. More than 30 Federal, State, academic, and private organizations and many technology-based companies have offices at Stennis. These residents share the cost of owning and operating the center with NASA and provide Americans positive returns on their investments. Stennis is the location of America's premier rocket engine test complex and, in 2009; the Stennis team completed 34 years of testing space shuttle main engines that were used on more than 130 space missions. Because of this rich history of testing engines for our Nation's human spaceflight over the past 40 years, Stennis is key to testing the rocket engines that will propel humans into deep space. Center leadership has established partnerships with private industry to test engines for the commercial space sector. With its unique assets, the Stennis Space Center is positioned to have a major role in the future of America's space exploration mission.

HANGAR ONE

Question. Have you received proposals for private investment in the external skin of Hangar One? If so, why does the NASA budget ask for significant taxpayer funds to re-skin Hangar One, particularly if such private proposals could conceivably generate solar energy?

Answer. To date, NASA has not received a written proposal to re-skin Hangar One from a private investor. In the late summer 2010, NASA issued a Request for Information (RFI) with the intent of gathering technical ideas on how to re-skin a structure of this type, to compare the Government construction estimate with the estimates of potential interested parties, and to ensure that the materials to be used were consistent with NASA thinking, given the historical preservation requirements. The results of this RFI produced only three responses to the call and all of them were partial. One of the respondents provided an estimate that approached

the Government construction estimate. More recently, NASA issued a Sources Sought Notice for the purpose of identifying qualified companies who could perform the work of re-skinning Hangar One. The results of this call are yet to be finalized.

There have been several unsolicited proposals received for the re-use of Hangar One after it is re-skinned by the Government. The proposals range from lighter-than-air technology operations to corporate office space, from an air and space museum to a Science, Technology, Engineering, and Math education center. The local communities have a strong interest in the re-use of Hangar One, in general, and passionately support its preservation for almost any use, including multi-purpose.

In 2005, NASA released an Announcement of Opportunity (AO) for photovoltaic panel installation to be mounted on the outside surfaces of Hangar One. The intent was to develop a source of funding to pay for the replacement of the siding. It was determined through this AO that due to the orientation of the Hangar, insufficient power could be generated to provide for an economic solution.

QUESTIONS SUBMITTED BY SENATOR KAY BAILEY HUTCHISON

INTERNATIONAL SPACE STATION (ISS) CONTINUATION

Question. The National Aeronautics and Space Administration (NASA), following the NASA Authorization Act of 2010, is planning to keep the ISS operating until at least 2020. Because this is an international space station, we cannot unilaterally decide for all members of the partnership.

First of all, it is my understanding that our ISS partners have agreed to the continuation of ISS operations through at least 2020. Is that correct?

Answer. The European Space Agency (ESA) recently decided to continue station operations to at least 2020. The Governments of Japan and the Russian Federation already have approved continued station operations beyond 2016. NASA received approval in the NASA Authorization Act of 2010. The Canadian Space Agency is working with its government to reach consensus about the continuation of the station.

Question. Is NASA aware of any outstanding issues, funding or otherwise, with any international partner that must be resolved in order to meet that objective?

Answer. The ISS partnership is committed to fully utilizing the ISS to its maximum potential. There remain issues to be worked among the partners, both individually and collectively, including long-term funding for the out-years, transportation logistics, nominal hardware and software updates, but currently NASA does not believe any of these are insurmountable. We will continue to work as a partnership to maintain the ISS and reap the benefits for future space exploration and those on Earth.

ISS RISK IF COMMERCIAL CARGO IS LATE

Question. I am greatly concerned now that the ISS has been completed, we will not be able to utilize it as we all have hoped.

It has been explained to me that within 18 months of the last shuttle flight to supply the ISS, steps might need to be taken to curtail activities with fewer crew members if commercial cargo delivery capabilities are not fully operational and able to service the ISS in time. I am confident that our commercial providers will reach the ISS, yet I worry about what happens if we are forced to scale back our use of our more than $100 billion investment.

At what point does NASA have to initiate contingency plans, or discussions with international partners to conduct supply missions if these capabilities need to be supplemented?

Answer. NASA is pre-positioning maintenance and logistics items on the final space shuttle mission as a contingency to mitigate any risk to ISS operations due to a delay in the availability of the Commercial Resupply Services (CRS) vehicles. The final shuttle mission, STS–135, is targeted for launch in early July. During the STS–135 mission, *Atlantis* will carry the Raffaello multipurpose logistics module to deliver critical supplies, logistics, and spare parts for the ISS, as well as a system to investigate the potential for robotically refueling existing spacecraft. This will help reduce the risk to ISS operations and maintenance should the CRS vehicles not meet their current launch dates. If the contracted commercial cargo services are not available at the beginning of calendar year 2012, there would be minimal impact to ISS operations. If commercial cargo services are not available by the end of calendar year 2012, there would be a reduction in utilization of the ISS. In that case, NASA would have to consider reducing the station's crew size to three in order to conserve supplies; this would in turn result in a reduced ability to conduct research

aboard ISS. The final shuttle flight will give the ISS the flexibility to maintain a six-person crew into fiscal year 2013 without any commercial cargo flights, effectively increasing the schedule margin by about a year.

Another risk reduction option is the availability of the ATV and HTV spacecraft. NASA already relies on bartered cargo transportation services provided by the ESA and the Japanese Aerospace Exploration Agency using these vehicles, and such barter agreements could be used to ensure a limited U.S. cargo delivery capacity, on the currently planned vehicles, as a stop-gap measure until the CRS vehicles are operationally available. NASA has also purchased cargo delivery services from the Russian Space Agency through 2011, though there are no plans to extend this service beyond the end of this year.

LIFE AND MICROGRAVITY RESEARCH

Question. With the upcoming addition of the Alpha Magnetic Spectrometer experiment to the ISS, NASA will have completed a monumental task that has taken more than a decade to complete. The ISS has been transformed from a small orbiting outpost to a fully capable research facility.

NASA has been tasked to utilize this opportunity. It has been given national lab status. Now, all that is needed is a comprehensive and integrated microgravity research program to take this opportunity and turn the station into a place where discoveries happen in order to enable exploration and also benefit the country.

The National Research Council (NRC) recently published a report that addresses key issues around the need for a solid microgravity research program. They believe that now is the time for a focused science and engineering program which can bring all the space stakeholders—researchers, the public, and policymakers—to an understanding that microgravity research can benefit us at home, and enable human space exploration.

This type of research is exactly what the ISS was built for and can be supplemented with free flying missions as well. Can you explain how NASA is planning to incorporate the recommendations in the report into the fiscal year 2012 budget and where this budget falls short, particularly in regards to taking advantage of the ISS?

Answer. The ISS represents an unprecedented national asset for advancing science and technology in the space environment, as well as stimulating new domestic economic expansion in low-Earth orbit. NASA is carefully positioning the ISS to maximize the value to the Nation through a series of initiatives designed to ramp up ISS research and development (R&D) projects now that the assembly phase is drawing to a close. NASA will pursue a diversified portfolio of scientific, technological, and economic development projects that draw upon the skills of all domestic sectors—government, academia, and industry—in order to leverage to the maximum extent the Nation's investment in the ISS.

The recent NRC decadal study on life and microgravity sciences represents an important element of guidance in assembling this balanced portfolio. With 65 "Top Priorities" for research, the report is unambiguous in its endorsement of the value inherent in the pursuit of biology, chemistry, and physics research and applications under microgravity, space-radiation, and ultra-vacuum conditions. Results from experiments conducted on Skylab, space shuttles, spacelab, spacehab, Mir, and the developing ISS, have consistently supported this conclusion over the past four decades. NRC's report will now serve as an authoritative and durable benchmark against which future progress can be assessed. NASA's supporting initiatives include:

—Competitive acquisition of a cooperative agreement with an external nonprofit entity charged to stimulate, develop, and manage the most effective use of 50 percent of the U.S. utilization capacity for national R&D needs. This initiative is being pursued in strict accordance with statutory direction embodied in section 504 of the NASA Authorization Act of 2010 (Public Law 111–267).

—Funding for strategic research assets for the pursuit of molecular, cellular, micro-biotic, plant, and animal research in the highly promising area of life sciences and biotechnology, and recovery of inorganic materials processing apparatus to re-establish progress in the development of exotic new materials of higher performance. These assets will be supported through a variety of management tools, including:

  —in-house development;

  —application of ISS program funds for capability enhancements, and;

  —pursuit of proofs-of-concept for known globally competitive applications; and

—Expansion of partnerships with universities, industry, and other government agencies based on a proven track record of success in forging new agreements for ISS-based R&D. The use of memoranda of understanding and Space Act

Agreements has effectively brought key resources to bear across a spectrum of new participants in space-based R&D, so that NASA is no longer the sole source of funding for value-driven R&D objectives.

—Assignment of a seasoned management group composed of leaders and staff with decades of experience in knowing what works, and doesn't work, in the formulation of multi-disciplinary and multi-organizational R&D teams for the pursuit of value-driven objectives.

The fiscal year 2012 President's budget provides the fiscal platform for launching and sustaining these key initiatives to maximize the value of ISS to our Nation. Under the guidance of NRC, and through a diversified portfolio that cuts across both the stages of research and all performing sectors of our economy, NASA is strategically positioned to carefully leverage the agency investment in ISS for R&D success in the coming era of utilization.

HUMAN SPACE FLIGHT SAFETY

Question. NASA is in the business of launching extremely valuable human lives into the harsh environment of space. No matter what NASA does, it will never eliminate 100 percent of the risk of sending people to space and those who are at the space station live in an environment where their lives are in danger every minute of every day. However, I am concerned that in the administration's rush to embrace commercial crew, that NASA is being asked to become less risk averse and thus will endanger lives.

NASA's own Aerospace Safety Advisory Panel has continually raised concerns about crew safety and specifically mentions the commercial crew acquisition strategy. It can be said that NASA may consider moving away from lessons learned from *Challenger* and *Columbia* and be settling for a strategy of "safe enough" as a trade for lowering development and seat costs.

How does NASA intend to determine safety for any provider wishing to carry NASA astronauts and be able to incorporate those standards into vehicles wishing to be a part of commercial crew?

Answer. At no point in the development and acquisition of commercial crew transportation services will NASA compromise crew safety. Simply put, U.S. astronauts will not fly on any spaceflight vehicle until NASA is convinced it is safe to do so.

NASA has unique expertise and history in this area and has learned hard lessons on the importance of crew safety. NASA will bring that experience to bear in the appropriate way to make sure that commercial crew transportation services are a success both programmatically, and with respect to safety. For example, NASA will have in-depth insight of the vehicle design via NASA personnel who are embedded in the contractor's facility. Additionally, NASA will impose strict requirements and standards on all providers that will be carefully evaluated and reviewed at multiple stages before a vehicle system is certified by NASA for crewed flight. NASA will make every appropriate effort to ensure that the systems selected to fly U.S. astronauts will be as safe as possible but also recognizes that these ambitious endeavor—human spaceflight—is inherently risky.

NASA's Commercial Crew Program Office at Kennedy Space Center in Florida is leading an effort to appropriately apply a series of existing health and medical, engineering, and safety and mission assurance requirements for the commercial space industry. The office is also developing but has not finalized the processes NASA will use to verify that these requirements have been met and to certify that a commercial partner's vehicle is capable of safely transporting agency personnel. This effort includes the full expertise of the agency including representatives from NASA's Office of Chief Engineer, Office of Safety and Mission Assurance, Office of Crew Health and Medical, the Flight Crew Office, and technical discipline experts (e.g., propulsion, structures, avionics, and ground operations).

Question. Are the final and definitive requirements in place so that in the competition for commercial crew services, companies can have those in order to accurately estimate vehicle development cost?

Answer. NASA is in the process of developing those requirements. We plan to have another workshop with industry in the August/September timeframe (the first Workshop was held on May 23–24, 2011, and NASA received extensive and valuable feedback from industry on our requirements). NASA plans to incorporate all this feedback into a baselined set of requirements by the end of the year, prior to the publication of any request for proposals for the development and certification of end-to-end crew transportation systems.

Question. Will vehicles that can reach the space station with crews that are not from NASA be able to come to the station with a lower amount of safety restrictions?

Answer. In accordance with the international agreements for the ISS, NASA has the responsibility "to establish overall space station safety and mission assurance requirements and plans" for the ISS. In the case of the Russian crew transportation vehicle, *Soyuz*, which typically has included NASA astronauts but not on all flights, the Russian Federal Space Agency is responsible for developing detailed safety and mission assurance requirements and plans, that "meet or exceed" the overall requirements established by NASA.

Similarly, current and future commercial crew or transportation vehicles that will conduct proximity operations with—and dock to—the ISS, must meet visiting vehicle requirements. Regardless of whether a particular vehicle is carrying NASA astronauts to the ISS, it must be operated in a manner consistent with these standards. The Russian crew and cargo vehicles have been shown to meet or exceed the visiting vehicle requirements.

QUESTION SUBMITTED BY SENATOR LISA MURKOWSKI

KODIAK LAUNCH COMPLEX (KLC)

Question. I compliment the National Aeronautics and Space Administration (NASA) for not only being the world leader in human space flight for the last five decades, but also for the many diverse scientific missions that have advanced our knowledge of the planet, the solar system, and the universe. These missions include the recent success of the three NASA satellites aboard the Space Test Program S26 mission launched out of the KLC last November. I am encouraged that the S26 mission along with the NASA Kodiak Star mission launched in 2001, out of Kodiak, indicates a willingness by NASA to utilize this key national spaceport. Please inform me of NASA's assessment of the value, utility, and security that the KLC provides as a supplement and backup to Vandenberg Air Force Base, in assuring that our Nation has access to space for the polar and highly inclined orbits that are only achieved out of our west coast launch sites?

Answer. NASA's Launch Services Program seeks to promote healthy competition in the expendable launch vehicle market and utilizes commercially available U.S. launch vehicles that are selected competitively based on "best value". NASA buys commercially available launch services for its scientific missions on the NASA Launch Services contract. As such, the commercial companies, not NASA, determine which west-coast launch site will be used to meet polar and highly inclined orbit requirements. Currently, the Athena line of rockets from Lockheed Martin are on the NLS contract using the Kodiak launch site to meet these requirements.

It should be noted that the S26 mission mentioned in the question did not use a NASA-procured launch service. It was a U.S. Air Force launch of a Minotaur IV (not commercially available because it uses excess ballistic missile assets) and the NASA spacecraft were secondary payloads.

SUBCOMMITTEE RECESS

Senator MIKULSKI. The subcommittee stands in recess until Thursday, April 14, at 10 a.m., when we will take the testimony of Secretary of Commerce Gary Locke.

[Whereupon, at 5:25 p.m., Monday, April 11, the subcommittee was recessed, to reconvene at 10 a.m., Thursday, April 14.]